THE HYGIENE OF THE SCHOOL CHILD

TERMAN

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THE HYGIENE OF THE SCHOOL CHILD

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TO
WILLIAM H. BURNHAM

EDITOR'S INTRODUCTION

The editor of this series has long held that an efficient teacher should know something as to the fundamental principles of child hygiene, and that a school principal should, in addition, know the fundamentals of schoolhouse hygiene. For schoolhouse hygiene we have, for some time, had a number of fairly serviceable texts, but of books relating to child development and the hygiene of instruction we have had but little in any form that teachers could use. Only recently may we be said to have come into the possession of such knowledge, and most of it is still locked up in medical and psychological journals and books.

The following treatise on the "Hygiene of the School Child" is an attempt to digest and interpret this recently accumulated knowledge, and to place it in usable form. The book might have been called, with almost equal propriety, a treatise on the "Hygiene of Growth," dealing, as it does, so largely with the fundamental facts of a child's physical development. In a companion volume, to be published later, the author will continue his interpretations by setting forth the relation of mental hygiene to the work of the school. In the two volumes, then, "The Hygiene of the School Child," and "The Hygiene of Instruction," will be presented the fundamental facts of child hygiene and development, such as parents, teachers, and students of education should know.

The time when the preparation of teachers can be made by a study of psychology and methods ought to pass. When it does it will mean that the health and physical welfare of a child will then be regarded as of as much importance as arithmetic and geography, and then a knowledge of the elements of child hygiene will be regarded as of fundamental importance in the training of every teacher. In many colleges and normal schools such a change is now taking place, and it is for such use that this textbook has been prepared. Teachers in service, too, ought to find such information as is contained in the following pages of great interest to them personally, and of much usefulness to them in their relations with their children.

Such an interpretation of scientific researches relating to growing children as this book contains ought also to prove of much interest and value to that large and rapidly increasing number of parents who are interested in the proper rearing and education of their children.

Ellwood P. Cubberley.

PREFACE

This work has been prepared as a textbook in school hygiene for the use of normal schools, colleges, and teachers' reading circles. It has been shaped by the conviction that the primary concern of such a text should be the child itself, — the hygiene of physical and mental growth, rather than the details of school architecture and school equipment. The architect and the engineer working alone cannot guarantee the healthfulness of school life. Hygienic buildings and equipment are necessary, but they do not go far in the conservation of the child. Moreover, the average teacher has little voice in the construction, ventilation, lighting, and equipment of school buildings. She must accept these as she finds them. But she has hourly opportunity, in her control of school activities, to observe or to violate the principles relating to the hygiene of physical and mental development.

On the phases of school hygiene here treated there exists, in spite of many regrettable gaps, a large and valuable literature. Most of it, unfortunately, has remained hidden away in medical treatises and scientific periodicals on hygiene. The author has endeavored to summarize and interpret the best of this rather technical literature for the use of teachers and parents.

If European investigations, particularly those of German writers, are quoted more often than American sources, this is because school hygiene as a science has been little cultivated in our own country. America does not yet have a single periodical of school hygiene; Germany has at least four of excellent scientific quality.

It would be vain to expect that a work having the scope of the present volume could be kept free from error. Either for lack of positive investigations, or because of conflicting data, many of the subjects treated remain in dispute. In such cases, it is not always easy to be judicial and impartial.

The author is indebted largely to the counsel and encouragement of friends for whatever merit this work possesses. Dr. E. B. Hoag, Specialist in Child Hygiene for the Minnesota State Board of Health, has furnished helpful suggestions for chapters XII to XV, inclusive. Dr. E. B. Huey, Assistant in Psychiatry, Johns Hopkins University, has given invaluable assistance in the preparation of the chapters on "Preventive Mental Hygiene." Without the inspiration of Professor William H. Burnham, the work would not have been undertaken; without the encouragement of the editor of the series, it could not have been completed.

STANFORD UNIVERSITY,
December 18, 1913.

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THE HYGIENE OF THE SCHOOL CHILD

CHAPTER I

INTRODUCTION: THE BROADER RELATIONS OF EDUCATIONAL HYGIENE

School hygiene as a part of the problem of conservation

The rapid development of health work in the schools during the last two decades is not to be regarded merely as an educational reform, but rather as the corollary of a widespread realization of the importance of preventive measures in the conservation of natural and human resources. The prevention of waste has become, in fact, the dominant issue of our entire political, industrial, and educational situation.

In many ways society is enlarging its interest in the individual. The *laissez-faire* policy of a few generations ago is being replaced by humanitarian foresight, restrictive measures, and large coöperative social undertakings. We are rapidly becoming conscious of hitherto unsuspected power to shape human destinies and are no longer willing to remain the passive plaything of uncontrolled social and material forces. The evolution concept is doing its work. Having at last consented to look at ourselves from the biological point of view, we proceed to harness the biological and social forces which will make for the development of a happier, healthier, and better race. Evolution has made us conscious of a future, has shown us how to attain it, and most important of all, has made that future a matter for our practical concern. Our highest boast is coming to be that we, the present generation, are living not only for ourselves, but also for the generations that are to follow.

Of course it must be admitted that Utopias for the betterment of human conditions are not a new invention. The imagination, fortunately, has always found satisfaction in the fanciful creation of an ideal social structure. But previous to recent governmental and scientific advances such dreams were but empty fancies, incapable of realization. The forces which make or mar the destinies of man were far less amenable to control than is the case to-day. At present the development of industrial processes and the various sciences of conservation give us hope that at least the worst conditions of poverty can be done away with; the remarkable progress of medicine demonstrates that many of man's physical ills can be overcome and many others eliminated by preventive means; and finally, the laws of heredity, when fully known and heeded, are capable of raising the average of mental, moral, and physical endowment well above where it now stands. Every civilized nation is becoming acutely conscious of the necessity of utilizing all possible means for conserving these vital resources and of adding to them.

Among the greatest of these influences is medicine, preventive and curative. Such diseases as smallpox, tuberculosis, diphtheria, malaria, yellow fever, typhoid, bubonic plague, and cerebro-spinal meningitis have rapidly yielded up secrets which make it possible, for the most part, either to prevent the disease or to cure it. The technique of diagnosis and of surgery has been refined beyond the boldest prophecy of a few decades ago. With the growth of our understanding of disease there goes *pari passu* a keener sensitiveness to the presence of physical imperfections. We now know that an amazing amount of physical defectiveness has always stared us in the face without our recognition.

Among the masses of people, however, there remains a vast amount of ignorance with regard to matters of health and disease. The daring researches of a few score bacteriologists are more than offset by the thousands of people who still use liverwort for jaundice because of the fancied resemblance of its leaf to the human liver; by the tens of thousands who treat infectious diseases by suggestion; by the millions who spend hard-earned money for patented consumption-cures. Popular notions regarding personal hygiene are little better than a seething welter of ignorance and superstition, not all of which is confined to those who are confessedly uneducated.

The cost of preventable disease

The cost of this ignorance in money, sickness, death, and grief is stupendous. Basing his estimate upon statistics of mortality for ninety different diseases and accepting the expert opinion of numerous medical specialists as to the ratio of preventability for these diseases, Professor Irving Fisher has reckoned that the general adoption of a few well-established hygienic principles would add fifteen years to the average span of human life. For the most part these fifteen lost years would be years of economic productivity. It is evident that every premature death entails an economic loss upon society, varying according to the age of the person dying. It is computed that the newborn child has an average money value of at least $95. The value increases to $960 by five years, to $4000 by twenty years, and drops again to $2900 by fifty years. The minimum average loss to society from each postponable death has been elaborately figured at $1700. Of the 1,500,000 deaths in the United States each year the combined opinion of the best medical authorities regards at least 42 per cent to be postponable, or 600,000. The annual loss to the country from this cause is therefore $1700 × 600,000, or $1,070,000,000.

Nor does this complete the story of waste. For each unnecessary death there are several cases of unnecessary illness, the total cost of which, counting medical attendance and wages lost, amounts to nearly $1,000,000,000 more. The Great White Plague alone involves an annual loss of not less than $500,000,000. Typhoid fever costs us some $200,000,000; malaria, $100,000,000, besides its indirect injury in undermining health; and the hookworm disease an equal amount. It is estimated that there are from 2,000,000 to 3,000,000 cases of malaria in the United States each year, and that about 2,000,000 persons suffer from the hookworm disease. The loss of economic efficiency from alcoholism, vicious habits, undue fatigue, minor ailments, and lack of expert direction of the human machine can only be vaguely guessed at, but it is probably greater than that from all the other causes enumerated. Apart from this, however, we suffer an aggregate calculable loss from preventable illness and death of about $2,000,000,000 per year, or over four times the total expenditures for public education. This is equal, at 4 per cent, to the annual interest on $50,000,000,000.

The meaning of such figures can be made more clear by a comparison with other values. The total physical wealth of the United States has been estimated at about $110,000,000,000, and the value of our annual agricultural products at about $9,000,000,000. Our railways are worth about $17,000,000,000, and the annual output of our manufactures about $15,000,000,000. Our *vital assets*, however, are by far the most important of all. Adopting Professor Irving Fisher's figure of $2900 as the average value of one individual to society, the total economic value of our 90,000,000 inhabitants reaches the sum of $250,000,000,000. This is almost exactly 1000 times the value of our hogs, for the conservation of which the nation expends more money than it does for the conservation of its children.

But statements of economic loss do not fully represent the importance of health conservation. Waste of life or health involves grief and moral suffering which cannot be measured in gold. Infant mortality illustrates the point. In the most enlightened countries from 15 to 20 per cent of the infants die in the first year of life. In Russia, Austria, southern Italy, and even in limited districts of England and Massachusetts infant mortality reaches 30 to 40 per cent. Although the economic significance of infant mortality is much less than that of tuberculosis, morally the two problems are of nearly equal importance.

The relation of education to the conservation of life

In the work of conserving national vitality we cannot rely altogether upon the progress of medical science and upon reforms of public health administration. These measures must be supplemented by a never-ending campaign for the enlightenment of the young in matters of personal and social hygiene. The practice of hygiene in the average home follows far in the rear of medical discoveries.

Infant mortality again offers an apt illustration. Bacteriology teaches that from one half to two thirds of infant deaths are due to the neglect of a few simple, hygienic precautions. In spite of this fact, statistics demonstrate that this needless slaughter has been but little affected by the advances of preventive medicine. It will continue little abated unless the new generation is educated to a different hygienic viewpoint. In the prevention of infant mortality, as well as in the conservation of vitality in general, no other agency is capable of contributing as much as the public school.

Numerous conditions peculiar to modern life have forcibly called our attention to the problems of hygiene. Among these are the industrial changes of the last century and the consequent urbanization of the population. In 1790, but 3.4 per cent of the population dwelt in cities of 8000 or over. By 1900, this had risen to 33.1 per cent. The growth of cities has greatly complicated the problems relating to food, housing, contagious disease, etc. Industrial methods have multiplied dangerous employments, have specialized in a most unhealthful way the physical activities involved in work, and have often favored the most wearisome and monotonous occupation of the mind.

So radical are the adjustments which civilization demands in our habits of living that the factors which controlled and directed the evolution of the human body have in large part become inoperative. Our modes of sedentary life tend less and less to bring into play the physical traits which were of greatest value in the primitive struggle for existence. Instead, excessive burdens are laid upon functions and organs never intended by nature to endure them.

If only the intentions of nature were respected during the period of growth and development the problem would by no means be so serious. The youth who has been brought into possession of his full psycho-physical inheritance would be in a position to conserve this inheritance in the face of great odds. This we do not permit. The healthful play of children has ever become more difficult. The introduction of universal education has changed the whole life of the child from one of active to one of sedentary occupation. As stated by Gulick, "so extensive a readjustment of the life habits of the young of a species has never before been attempted."

We do not yet know what the result of this experiment will be, but it is unreasonable to suppose that man presents any exception to the biological law that the ultimate survival of an organism is threatened whenever it is subjected to conditions of environment widely different from those which directed its evolution. We have taken the child out of its natural habitat of open air, freedom, and sunshine, and for nearly half his waking hours we are subjecting him to an unnatural regimen, one which disturbs all the vital functions of secretion, excretion, digestion, circulation, respiration, and nutrition.

If all children were perfectly healthy when received into the school, they might be expected to make the adjustment with little or no permanent injury. But the school does not deal chiefly with healthy children. Medical inspection in scores of American cities demonstrates that as a rule not more than one third of our school children are free from physical defects prejudicial to health. Of the 20,000,000 children enrolled in our schools some 14,000,000 are more or less handicapped in this way.

Not far from 2,000,000 (10 per cent) are suffering from a grave form of malnutrition; 10,000,000 (50 per cent) have enough defective teeth to interfere seriously with health; at least 2,000,000 (10 per cent) suffer from obstructed breathing due to adenoids or enlarged tonsils; probably 2,000,000 (10 per cent) have enlarged cervical glands which need attention, many of these being tuberculous; at least 10,000,000 (50 per cent) are, or have been, infected with tuberculosis, of whom about 2,000,000 (10 per cent) will later succumb to the disease; 4,000,000 (20 per cent) have defective vision; over 1,000,000 (5 per cent) have defective hearing; about 1,000,000 (5 per cent) have spinal curvature or some other deformity likely to interfere with health; not far from 500,000 (2½ per cent) have organic heart disease; and at least 1,000,000 (5 per cent) are predisposed to some form of serious nervous disorder.

Health work in the schools must be extended

The fact that the school doctor has been called in to examine and advise does not signify that the gravity of the situation has been apprehended. Teachers have simply found physical defects an impediment to the pupil's school progress and desire their removal. The school doctor spends some three to six minutes in the examination of each pupil, looking only for the gross and external symptoms of defectiveness. Having usually the point of view of the physician, his search is for disease. His training has not always fitted him to discover incipient deviations from the normal or even to see the necessity of doing so.

Our plea is for a broader conception of the functions and scope of educational hygiene. The usual attention given to heating, lighting, ventilation, and gross physical defectiveness is but the merest beginning. The school instead of causing sickness and deformity must be made to preserve the child from all kinds of morbidity, repair his existent deformities, combat his unfavorable heredity and the bad conditions of his environment; in a word, fortify his constitution and render him physically and mentally fit for the struggles of life.

The greatest problem of conservation relates not to forests or mines, but to national vitality, and to conserve the latter we must begin by conserving the child. We are hampered, however, by the lack of positive knowledge of the influences which mold a child's physical and mental development. Many of the questions relating to this problem can never be answered until they have been attacked on a broad scale by systematic and scientific methods of research. To secure proper scope for such research, the schools must be thrown open to it; to insure adequate support, it must be made a public undertaking.[1]

No other agency compares with the school in the opportunities offered for contributing to the health of the succeeding generation. We cannot legislate desirable habits of living into men and women, but we may be able to mold after our ideals the hygienic habits of the child.

The most characteristic tendency of present-day education is its progressive socialization, the increas-

[1] For a list of unsolved problems in child hygiene see reference 22, at end of this chapter.

ing extent to which society is utilizing the school as an instrument for the accomplishment of its ends. We are coming to believe that it is legitimate to levy upon the school for any contribution it is capable of making to human welfare. This social conception of education is quite familiar. Only let us extend its application to all fields of personal and social hygiene and the school will help to deliver us from a burden which is more oppressive than the burden of militarism; for physical inefficiency, sickness, and premature deaths are costing us as much as all our crime and as much as a good-sized perpetual war besides.

Apart from such considerations as the above it is not possible to understand or evaluate the modern crusade for medical and hygienic supervision of schools. It began as a reflection of the popular interest in matters of health; it will end by becoming the most effective and convenient instrument for the attainment of a higher national vitality.

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CHAPTER II

THE PHYSICAL BASIS OF EDUCATION

The biological perspective

It is necessary for us as teachers to take the biological point of view in all our thinking and to seek our educational philosophy in the laws of growth. The task of molding human lives is one which can be accomplished only by an appeal to those biological processes which are common alike to animals and to man. For in the strictest sense man is as much a natural product of evolutionary laws as are his brothers of the forest. His biological equipment is in general the same; the number and distribution of his parts, the individual tissues even, and to no small extent the physiological functioning of all his organs. He is subject to many of the same diseases and is tormented by the same parasites. Because man's nervous system is built upon the same general plan as that of the other higher mammals, his mental equipment differs from theirs more in degree than in kind. His senses are the same, he is moved by similar instincts and emotions, and his intellect embraces no "faculty" which is not present in cruder form in the mental life of other animals. He is obedient to the same laws of heredity, and is therefore capable on the one hand of improvement by eugenics, and on the other hand subject to racial degeneration.

For the understanding of childhood, especially, the biological perspective is absolutely essential. It is then that natural instincts, primitive modes of mentation, and growth influences of remote origin are most in evidence. If the lengthened period of immaturity in man is not conceived of in its evolutionary setting, education cannot set a rational goal or choose aright the processes by which the goal is to be attained. It is our tendency to view the child as a being set apart from the rest of organic creation which causes us to neglect the physical limits and determinants of human possibilities, to teach children as though they were disembodied spirits, to judge the child by adult standards, to forget that the best of education is but wisely directed growth. Besides a general biological orientation, such as might be expected from a well-planned course dealing with man's place in nature, every teacher should have considerable acquaintance with the problems and principles mentioned in the following paragraphs.

(*a*) *The order of physiological maturity.* Every part of the body has its own order of development and its own critical periods, the nervous, muscular, circulatory, respiratory, and digestive systems in particular. Education must follow this order, measuring its demands and requirements by the child's stage of maturity. Many an educational problem is solved by growth alone.

(*b*) *The main factors in mortality and morbidity.* The teacher should know what diseases are prevalent among children at various stages of development. The degree of resistance to disease determines in large measure the kind of education the child should have. Instruction can wait, as Dr. Burnham reminds us, but the demands of health are imperative. Health first, then education, should be the motto. We have hardly begun to appreciate the real significance of a clean bill of health and heredity. We make no inquiries of this sort regarding the new pupil, but ask only his marks in the subjects of instruction. It is necessary to know something about all the physical abnormalities commonly met with among school children, defects of eyes, ears, nose and throat, teeth, spinal deformity, malnutrition, anæmia, nervous states, etc. This knowledge should include for each defect something of its causes, its effects upon general health, its symptoms, and the appropriate methods of treatment, both educational and medical. Too often tuberculosis steals the child or spinal curvature deforms him while we wrangle over rival methods of teaching him geography or grammar or spelling.

(c) *The relation between mental and physical conditions.* The nervous system is so intimately concerned in every act of knowing, feeling, and willing that, if our knowledge were only greater, education could be described in purely neurological terms. When we know more about the physical basis of mental life we shall quit teaching grammar to feeble-minded children who cannot learn to count money. We shall appreciate the wisdom of the old proverb which tells us that "it is impossible to make a silk purse out of a sow's ear." We shall understand that the difference of some billions of brain cells between the imbecile and the genius is a difference which education cannot wipe out or afford to ignore. We shall not expect to find normal instincts, emotions, intelligence, or conduct in children who are unhealthy or disinclined to play. We shall understand that fatigue and work have their strict physiological determinants dependent upon bodily rhythms, the disintegration of cell tissue, the accumulation of toxins, processes of waste elimination, repair, and the like. We shall think even of criminality, truancy, inattention, laziness, etc., in terms of a possible physical cause.

(*d*) *The dynamic aspects of education.* The education of the mind is closely related to the activity of the muscles. In the race and in the individual, mind and muscle develop together. The human hand and the human intellect would each have been impossible without the other. The low-grade feeble-minded are always deficient in motor power and in delicacy of coördinations. Their cerebral activities are as clumsy as their manual, and the former can be improved by the education of the latter. The motor element is present in all our thinking. Every school subject has its dynamic aspect. We cannot truly possess knowledge until we have used it. A thing *is* what we can *use* it for; our idea of it is determined by our motor attitude toward it. One's whole personality is a bundle of accomplishments and possible accomplishments. Thinking, biologically speaking, is never its own end, but a means toward adaptation, which is essentially motor.

When we have applied this biological point of view in our educational psychology we shall less often exalt knowing above doing. Much of the time we now give to book instruction will be replaced by opportunities for activity. The educational aim will lose its bifurcated aspect and the child will be recognized as an organic unity. The child's mind will cease to be the enemy of his body, and the welfare of each will be sought in the maximum culture of the other.

Knowledge without health cannot profit us. "Non scolæ, sed vitæ," interpreted by hygiene, means that success in life depends as much on the integrity of the energy-getting processes as on the accumulation of knowledge, and that the school dare not confine its work to the latter. Emerson is literally correct when he tells us that the strong heart helps us to resist temptation. So do healthy muscles and a sound digestion. To fill the child's blood with four and a half million red corpuscles per cubic millimeter and to enrich it with the oxygen-carrying hæmoglobin falls as much within the legitimate field of education as instruction in the "Three R's."

A system of education like our own, giving such a disproportionate amount of training to the thinking activities, would have seemed preposterous to the Greeks or Romans. Their ideal of "a sound mind in a sound body" needed only the scientific basis of hygiene and medicine to make their scheme of education the best the world has seen, social and industrial conditions considered. The religion of medieval Europe taught that the salvation of the soul was dependent upon the debasement of the body. Europe learned the lesson only too well. A frank exposition of the universal neglect of personal and public hygiene in the Middle Ages would bar this book from the United States mails.

Unfortunately, modern education has been influenced in its attitude toward the body by medieval rather than by Greek and Roman ideals. Physical education has played an insignificant part in modern educational theory and still less in educational practice. Our schools are still what the Germans call *Lernschule.* The latest textbooks on the "principles of education" all but ignore the subject, and no comprehensive philosophy of physical education has yet been attempted. In actual practice the subject will not receive the attention it deserves until the educational machinery for its control is as complete and as well organized as our best system for the supervision of instruction.

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CHAPTER III

THE GENERAL LAWS OF GROWTH

Sources of data

A COMPLETE census of the physical conditions of a nation's children, planned with special reference to discovering the laws of growth and their modification by various environmental and social influences, would be beyond comparison more valuable than all the censuses of property and population ever taken. But no nation has ever taken an inventory of its chief resource, the raw material for the new generation. Scattered investigations have been made, however, in nearly all countries, involving altogether measurements of more than 150,000 children of both sexes and different ages. Not all of these have been taken with uniform procedure or with sufficient precautions to guard against error, nor has the statistical treatment of the data always been satisfactory.

To review in detail even the most important anthropometrical studies of growth would carry us beyond the scope of the present chapter, the purpose of which is limited to the presentation of the most important laws of growth.[1] Growth statistics are likely to be mislead-

[1] The most important of these studies are those of Porter, Peckham, Bowditch, West, Boas, and MacDonald, in America; Roberts, in England; Hertel and Malling-Hansen, in Denmark; Geissler,

ing unless used with extreme caution. Measurements, of height and weight, especially, are of doubtful value as guides for the hygiene of physical development. In the first place, these are not simple phenomena, but complex resultants of many factors, the individual significance of which is in no way elucidated by the numerous tables of established "norms." Our knowledge of growth needs to be much more specific than this and should include exact information relating to the development of all the organs, the significant changes in their mode of functioning from birth to senescence, the important abnormalities of development, and the degree of resistance to various diseases resulting from the ensemble of physical traits of each age. In the second place, the growth status of the *individual* can never be evaluated by a table of norms computed from growth *averages*. Each individual is a law unto himself. A school child may be several inches shorter and many pounds lighter than the average for children of his age, race, and sex, while fully reaching the standard which nature set for *him*. Nor can we set any limits above and below which abnormality is reliably indicated in the individual child. Measurements of size can give little clue to the normality of the processes within. Growth averages are, however, of value as

Schmid-Monnard, Engelsperger, and Lucy Hoesch-Ernst, in Germany; Chaumet and Binet, in France; Zak and Viazemsky, in Russia. More detailed studies of the phenomena of growth will be found in the admirable summaries of Burk, MacDonald, and Hoesch-Ernst, while the extensive treatment of the subject in Hall's *Adolescence* is unequaled for suggestive interpretation.

norms for comparative study of *masses* of children different in age, sex, race, social environment, etc.

Of the scores of available curves and tables which might be presented for this purpose, those which follow are the most reliable for use with American-born children.

TABLE 1

Approximate average age	Number of observations	Boys			Number of observations	Girls		
		Average for each year: inches	Absolute annual increase: inches	Perc'tage annual increase: per cent		Average for each year: inches	Absolute annual increase: inches	Perc'tage annual increase: per cent
5½	1535	41.7			1260	41.3		
			2.2	5.3			2.0	4.8
6½	3975	43.9			3618	43.3		
			2.1	4.8			2.4	5.5
7½	5379	46.0			4913	45.7		
			2.8	6.1			2.0	4.4
8½	5633	48.8			5289	47.7		
			1.2	2.5			2.0	4.2
9½	5531	50.0			5132	49.7		
			1.9	3.8			2.0	4.0
10½	5151	51.9			4827	51.7		
			1.7	3.3			2.1	4.1
11½	4759	53.6			4507	53.8		
			1.8	3.4			2.3	4.3
12½	4205	55.4			4187	56.1		
			2.1	3.8			2.4	4.3
13½	3573	57.5			3411	58.5		
			2.5	4.3			1.9	3.2
14½	2518	60.0			2537	60.4		
			2.9	4.8			1.2	2.0
15½	1481	62.9			1656	61.6		
			2.0	3.2			0.6	1.0
16½	753	64.9			1171	62.2		
			1.6	2.5			0.5	0.8
17½	429	66.5			790	62.7		
			0.9	1.4				
18½	229	67.4						

Showing average American height, mathematically calculated, by Dr. Franz Boas, from measurements of 45,151 boys and 43,298 girls in the cities of Boston, St. Louis, Milwaukee, Worcester, Toronto, and Oakland; also the absolute and the percentage annual increment of same.

TABLE 2

Age	Boys			Girls		
	Average for each age: pounds	Absolute annual increase: pounds	Annual increase: per cent	Average for each age: pounds	Absolute annual increase: pounds	Annual increase: per cent
6½	45.2	....	....	43.4	....	....
7½	49.5	4.3	9.5	47.7	4.3	9.9
8½	54.5	5.0	10.1	52.5	4.8	10.0
9½	59.6	5.1	9.3	57.4	4.9	9.3
10½	65.4	5.8	9.7	62.9	5.5	9.6
11½	70.7	5.3	8.1	69.5	6.6	10.5
12½	76.9	6.2	8.7	78.7	9.2	13.2
13½	84.8	7.9	10.3	88.7	10.0	12.7
14½	95.2	10.4	12.3	98.3	9.6	11.9
15½	107.4	12.2	12.8	106.7	8.4	8.5
16½	121.0	13.6	12.7	112.3	5.6	5.2
17½	....	....	....	115.4	3.1	2.8
18½	....	....	....	114.9	....	....

Showing the average American weight mathematically calculated, by M. de Perrot, from the data of about 68,000 children in the cities of Boston, St. Louis, and Milwaukee; also absolute and percentage annual increases of same.

The averages in the above tables are graphically represented in the curves given in figures 1 and 2.

Among the most important facts to be gleaned from measurements of growth are the following: —

(1) *Absolute increment and percentile increment.* The curves showing these are quite unlike. The former refers to the actual

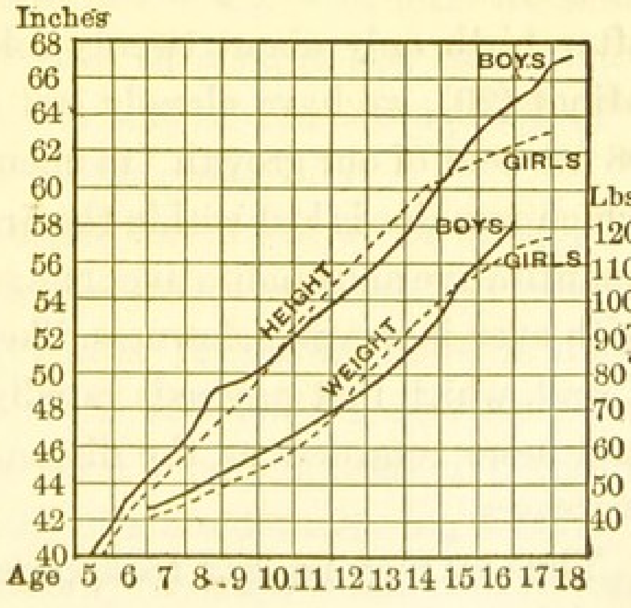

FIG. 1

Showing Growth in Height and Weight

gain in pounds or inches; the latter is the ratio (expressed in percentage) between the gain in a given period of time and the total weight or height. Although growth is usually described in terms of absolute increment, percentile increment would be less misleading.

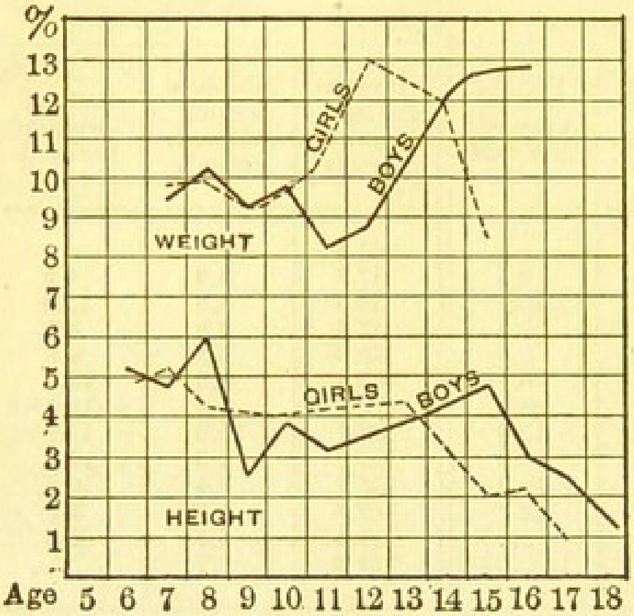

FIG. 2

Showing Annual Percentile Increment of Growth in Weight and Height

Measured by percentile increment, growth before birth is almost infinitely more rapid than it ever is again. In the nine months preceding birth, weight increases nearly a billion-fold; in all the years after birth only about twenty-fold. As expressed by Minot (20), we have already lost at the time of birth 98 per cent of our growth "momentum." Most of that which remains is lost within the first three years. Both quantitative and qualitative changes succeed each other with ever increasing slowness, like the construction of a wall, which first proceeds rapidly and becomes more and more retarded as the distance from the ground increases.

Thus we may be said to approach senescence most rapidly in the early years and months and less rapidly as life proceeds. Because cell changes are taking place so much more rapidly in the first decade than in the second, more rapidly in the second than in the third, etc., we may infer that the educational possibilities (considered also in percentile terms) decrease in similar proportion. The mental progress made by the child in the first year is in this sense infinitely greater than that of the tenth or the twentieth year. The possibilities of modifying the growth and physiological functioning of the various organs, including the central nervous system, rapidly diminish as the body cells assume their stable and mature characters. For the purposes of education youth is more important than manhood or womanhood, and childhood more precious than either.

(2) *Oscillations in growth rate.* In general, the curves for percentile increment in height and weight show a retardation of growth at or before school entrance, a slight acceleration at about 7 for girls and 8 for boys, a pre-pubertal minimum coming with girls at 9 and with boys at 11, followed by a rapid rise to the maximum adolescent growth rate at the average age of 15 for boys and $12\frac{1}{2}$ to 13 for girls.

The exact significance for education or for hygiene of the oscillations in growth rate preceding puberty is unknown. As will later be shown there is reason to believe that the slight acceleration at 7 or 8 may be partly explained as a rebound from a preceding retardation caused by the child's entering school. It may be influenced also by the improvement in chewing surface which occurs at this time, due to second dentition. It is well established that the period of about 6 to

7 is marked by an increased frequency of nervous and digestive disturbances.

The revolutionary growth changes of adolescence must be interpreted in relation to the simultaneous transition, no less marked, in the instinctive, emotional, and intellectual life. It is not by accident that the curve for interest in mathematical puzzles (Lindley) and the curve for frequency of religious conversions (Starbuck) reach their maximum simultaneously with the curve of growth, and that they reveal almost exactly the same sex differences. The rapidity of growth at this time suggests the desirability of bringing to bear every possible influence that will aid in implanting and fostering desirable traits of mind and body before the mold has set. This principle is applicable alike to pedagogy and to hygiene. The youth of 18 with crooked spine, undeveloped lungs, and diseased heart is hardly more hopeful from the point of view of hygiene than the juvenile delinquent from the standpoint of morals and religion.

(3) *Growth rate and resistance to disease.* Investigations on this point are somewhat contradictory, but indicate on the whole that, although the mortality rate is lowest when the adolescent acceleration is greatest, morbid conditions of both mind and body are at that time most frequent. This is particularly true of girls. It is necessary, however, to discriminate diseases and to determine the curve of liability to each. To lump together diseases and complaints of every kind and to enumerate them as so many "illnesses" or "de-

fects" is of doubtful value, at best, and may be misleading.

(4) *A comparison of the curves for girls and boys shows an important difference between the sexes.* The girls reach their pre-pubertal minimum of growth rate a year or two earlier than boys and their maximum adolescent rate about three years earlier. Rotch and Boas have shown that the sex difference in physiological maturity amounts to more than a year by the age of 5 years. The significance of "physiological age" differences is treated in chapter VI.

(5) *The relationship between physical and mental growth is a mooted question.* In a sense, of course, mental growth must be supposed to rest upon some kind of physical basis, and the question resolves itself into that of the parallelism between growth in height or weight and development of the neural structure. There is no reason for believing the parallelism to be perfect, and it is a matter of common observation that a few children are mentally advanced beyond their own individual norm of height and weight while others are correspondingly retarded. This is but another way of saying that height and weight are not reliable indices of a child's physiological maturity.

For masses, however, the relationship undoubtedly holds. Porter's data from 34,500 St. Louis children show distinctly that pupils of every age who are above grade are taller and heavier than pupils of the same age who are below grade. As an illustration of Porter's findings, the average weight of 11-year-old boys in the sixth grade was 73.34 pounds; in the fifth grade, 71.29; in the fourth grade, 69.24; in the third, 68.12; in the second, 65.45; and in the first grade, 63.5. The only studies of importance which fail to confirm this conclusion are those of Gilbert and West, but their method of estimating intelligence (by using the teacher's classification of "good," "average," or "dull") is unsuitable for this purpose and in all probability accounts for their results. Since the large, dull, retarded pupils and the small, bright, advanced ones are found in the same class, the teacher is likely to overestimate the dullness of the former and the intelligence of the latter.

Roberts's tables show that the professional classes of England are distinctly taller than any other social class, and that the professional men who are also Fellows of the Royal Society are above the average for professional men in general. Numerous investigations have demonstrated the average inferiority in height and weight of the feeble-minded. Goddard's figures indicate that the average idiot begins to fall below the average normal child at about 7 years, the imbecile at about 11, and the moron at 14. Shuttleworth found 300 idiots and imbeciles to average 2 inches below normal at 10 years and 3 inches below at 15 years. Bayerthal's measurements of 1006 normal children of Germany show an unmistakable correlation, for masses, between head circumference and intelligence. All who have conducted measurements of mentally defective children agree in assigning them a smaller average circumference of head than is found among normal children of the same age.

The conclusion, justified by the data, that physical superiority usually accompanies mental superiority, is of the greatest practical importance for education. The opposite opinion has been very widespread and has been made the excuse for the common practice of restraining the school progress of mentally superior children. In the exceptional case of intellectual precocity accompanied by physical weakness, this is the wise course; but applied to supernormals as a class, the principle is unfavorable to the culture of genius and inimical to social progress. Instead of restraining the talented child, we should encourage him to live up to his best possibilities.

(6) *The relation of pubertal retardation to ultimate size.* Another law of growth somewhat related to the above, and of the greatest importance for hygiene, is that in case of delayed puberty adolescent acceleration is brief in extent and leaves the individual below the ultimate size of those who reach puberty early. In such children the growth energy of adolescence, though rapid, is too quickly expended to permit the gain of all that has been lost. This relation, which is quite the reverse of common opinion, holds for races as compared with one another and for different individuals in the same race. Hygiene, therefore, should look with suspicion upon all influences which artificially retard growth in the adolescent or pre-adolescent years.[1]

[1] See pages 100 and 210.

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CHAPTER IV

THE FACTORS INFLUENCING GROWTH

The factors which influence growth may be classed into two groups: (*a*) *Internal or hereditary*, including racial heredity, the influence of immediate ancestry, and the fact of sex. (*b*) *External or accidental influences*, including malnutrition, acute and chronic diseases, bad housing, city life, overwork, lack of exercise, temperature, season of the year, air, ante-natal influences, etc.

(*a*) *The internal factors*

Racial heredity. Racial heredity is of prime importance in determining both the ultimate size of the individual and the time of adolescence. Growth norms for the races of northern Europe, for example, cannot be used as standards for judging the growth status of Japanese, South Italian, or Spanish children. Standards which represent averages of the measurements obtained from mixed groups of Scandinavian, English, Irish, German, French, Italian, and Russian children can have no meaning or legitimate use.

It was formerly believed that nearly all primitive races, particularly those living in hot climates, are precocious in their physical development. More recent investigations, however, tend to discredit this belief.

Reche's study showed that Melanasian girls reach puberty at an average of 16 to 17 years; that Melanasian children are inferior to European children in size at all ages; that their final size is attained earlier; and that girls excel boys at all ages preceding adolescence. Baelz found the same principle of retarded puberty and early arrest of growth to hold also for the Japanese, though to a less degree, while children of mixed Japanese and European descent fell halfway between those of the pure stocks.[1] Bobbitt (2) found from measurements of 1618 Philippine children, ages 6 to 21, that the pubescent acceleration almost coincides in time with that for American children, but that growth is arrested somewhat earlier. Compared to the masculine standard for her race, the Philippine girl is much superior in power of grip to the American girl. From the viewpoint of hygiene it would be interesting to know whether the inferiority of the American girls is inherent, or the result of pampering, indoor life, unsuitable dress, etc.

Family heredity. The influence of immediate ancestry is also an important determinant of growth. Children of the same parents show a high average resemblance in intelligence (brain growth), resistance to disease, and the like, as well as in height, weight, and various other bodily dimensions. Wiener's measurements of his four sons from infancy to maturity show that the fourth son, who was the offspring of a

[1] For account of data from Reche and Baelz see Meumann's *Experimentelle Pädogogik*, 2d edition, vol. I, p. 97.

different mother, had a growth curve quite different from the other three.

According to Karl Pearson and his co-workers in the Galton Eugenics Laboratory, the physical and mental resemblances of offspring to parent are marked by coefficients of correlation falling for most traits between .40 and .50. This means that for any given trait the son may be expected to differ from the average from 40 per cent to 50 per cent as much as the father does.

The influence of age of parents on the growth curves of children is not known, but statistics of feeble-mindedness indicate that heredity is most favorable when the mother is between the ages of 20 and 40, and the father between 25 and 50.

The relation of hygiene to eugenics. It is of the greatest urgency for hygiene that the heredity factors, both racial and family, be separated from the influences of environment. It is folly for hygiene to aim at results which are attainable only through the agency of eugenics. Hygiene, for example, could do nothing for the cretins[1] of Aosta beyond improving their conditions a little by humanitarian treatment; but the defect was practically eradicated in a few years by segregation of the male and female cretins during reproductive age. It is possible also that heredity is a more important factor in the production of tuberculosis, cancer, arterial sclerosis, and many other diseases than it is usually believed to be. The same may hold also for intelligence and traits of character.

[1] See p. 55.

Neither hygiene nor eugenics should despise the scope of the other; each should confine its efforts to that which it is best fitted to accomplish. It would be especially unfortunate if hygiene should neglect the limitations which a defective physical endowment places upon its best efforts. On every hand we see hygiene engaged in the effort to patch up the faults of heredity, and largely in vain. It is certainly the duty of *euthenics* [1] to make the best of the raw material at command, but the euthenist should not be satisfied to work forever with faulty material. Speaking generally, it is safe to say that most of the great plagues, both physical and moral, which afflict mankind will never be eradicated except by the united efforts of hygiene and eugenics.[2]

(*b*) *The external factors*

The extent to which external factors may affect growth determines the value of corrective and hygienic measures. If unfavorable environment has only minor effect on normal growth tendencies, then the wisest precautions of hygiene will avail but little in correcting the deficiencies of growth. That external influences are potent, however, is abundantly proved by data from many sources, though the exact extent to which they are operative is not always clear.

Influence of economic and social conditions. The

[1] *Euthenics* pertains to the favorable influences of environment. It is contrasted with *eugenics*, which refers to improvement of the race through application of the laws of heredity.

[2] Specific data bearing on heredity as a factor in causing various physical defects are reviewed in succeeding chapters.

conditions which accompany bad social environment are perhaps the most important, — unsuitable diet and clothing, crowding, inadequate ventilation, overwork, lack of parental care as regards sleep, exercise, personal habits, etc. No serious effort has ever been made to separate and measure the individual effects of these various factors, but the injury produced by the combined influence of all is revealed by the following representative findings.[1]

TABLE 3

Social class	I	II	III	IV	V	VI	VII	VIII	IX
Number of cases	150	294	392	304	181	293	341	840	66
Mean height (inches)	55	54.	53.5	53.	52.5	52.	51.5	51.	50

(Class I is highest, class IX lowest in social scale.)

Superiority of children of non-laboring classes over children of laboring classes is shown in Table 4.

TABLE 4

Age	13	14	15	16
Height superiority (inches)	2.66	3.35	2.89	3.47
Weight superiority (pounds)	10.33	14.60	13.63	19.64
Superiority in chest girth (inches)	3.17	3.37	3.21	4.11

Comparison of children of the best and worst classes in Edinburgh showed a difference of 5 pounds for boys and 10 to 12 pounds for girls in favor of the better classes. The difference in height was 2.65 inches for boys and 3.82 inches for girls (8, pp. 168 and 210). Grouping 72,857 children of Glasgow into four classes according to poverty gave a difference of 2.5 and 3.8 inches for the ages 10 and 14 respectively, and a

[1] Roberts's *Manual of Anthropometry*. London, 1878, p. 32.

difference of 3.2 and 5.1 pounds in weight for the same ages. Wilson found a difference of 9.2 pounds for boys and 6.8 pounds for girls between the slum children of Birmingham and the children of a model town in the near vicinity (13). Arkle found children of the best class superior to those of the poorest class by 3.8 inches and 6.3 pounds at 7 years, and by 6.5 inches and 23 pounds at 14 years (1). Comparing several thousand 14-year-old children of the artisan class with children of the most favored class, Dukes finds the former inferior by 3.35 inches in height and 14.59 pounds in weight.

In Freiburg, Germany, Geissler's and Uhlitsche's measurements of 1,874 children showed a superiority of boys of the better classes varying from 2.4 centimeters at 6½ years to 4.7 centimeters at 13. The corresponding figures for girls ranged from 3.9 centimeters at 6½ years to 5.1 at 13.

Similar differences have been discovered by many other investigators in various parts of Europe and America. The contrast appears also in the populations which are the most homogenous, racially, and almost to the same extent as where the upper and lower classes differ in racial heredity. In some cases social class is even more potent in determining size than race itself.[1]

When conditions are unfavorable enough to affect growth in height and weight it is reasonable to suppose that the effects would extend to many of the organs of the body and to their physiological functioning. That

[1] Hoesch-Ernst.

such is the case seems to be well established. One of the main effects is the delay of puberty and the abbreviation of the period of accelerated adolescent growth. The children of the poor, on the average, reach puberty late and cease growing early. Meyer's figures for 6000 German girls showed a difference of four fifths of a year in the average age of puberty between the wealthy and the poor classes. The extensive investigations of Key, Roberts, and the English Anthropometrical Committee agree that the onset of adolescence is delayed from one to two years with the lower classes. In such cases the adolescent growth comes with a rush, is abnormally rapid for a relatively brief period, and comes to a standstill before the earlier losses have been made good. In every respect this unnatural course of growth is less favorable than a steady growth through a longer period. Disturbances of physiological functions, disharmonies of growth, physical defects, anæmia, nervous instability, etc., are more likely to occur. Statistics of medical inspection confirm this by showing a larger amount of defectiveness of almost every kind among the children of the poor.

Analysis of environmental influences. What is the relative amount of influence exerted by the numerous factors which accompany poverty? Science has solved harder problems, but has not yet set itself seriously about the solution of this one. Our universities have accomplished more toward ascertaining the optimum growth conditions for corn, wheat, and hogs than for children. Thus far we have little scientific basis for assertions regarding the individual effect upon healthy growth of insufficient sleep, underfeeding, inadequate clothing and shelter, lack of opportunity for play, overwork, child labor, neglect of personal hygiene, etc.

By classifying Edinburgh children according as they lived in houses of one room, two, three, four, or more, Mackenzie was able to show a progressive increase in height and weight with better housing conditions; but this gives us little clue to the effect of housing itself, since children who live in one-room houses are also at a disadvantage as regards sleep, play, work, food, parental care, etc. Measurements showing the subnormal size of factory children in the Southern States are just as little enlightening as to the influence of child labor on growth. The marked differences found by Hertz, Hoesch-Ernst, and many others between city and country children are more decisive as to the wholesome influence of rural life. Country children are distinctly superior to city children of the same social class in height, weight, chest girth, and power of grip. The chest girth of country girls approaches much nearer to the average for boys than is true of girls in the cities.

Nutrition. Of all the factors concerned, however, we have reason to believe that the nature and the quantity of food are the most important. Adequate nutrition is the necessary foundation of healthy growth, and the lack of it the most productive cause of the low vitality which favors tuberculosis and certain other diseases. There is hardly a defect found among school children which is not in greater or less degree produced by malnutrition. In this category we may include even eye-strain, dental defects, spinal curvature, and nervousness, as well as the infectious diseases. Children in open-air schools where feeding is practiced gain promptly and continuously in weight, and hold the advantage gained.[1] It is impossible, however, without further researches, to apportion the credit for this among the numerous factors involved, — fresh air, exercise, decreased study, feeding, sleep, medical and nurse attendance, etc. That the entire regimen of the open-air school exerts a powerful influence on crude growth is perfectly well established, and the influence on the physiological functions appears to be even more pronounced.

One further point deserves emphasis. The investigations indicate that the influence of poor nutrition in the early years tends to last throughout the growth period. Whether the child will reach a normal adolescence and maturity is partly determined before he starts to school. As is shown in chapter VIII, the resistance of the permanent teeth to decay is partly determined in the first years of childhood. Russow's growth measurements of the same children for eight years show that artificially nourished children fall behind the breast-fed from two to three kilograms in the first year and do not catch up. It is possible, however, that mothers who are unable to nurse their children are

[1] See chapter XII of *Health Work in the Schools,* Hoag and Terman.

subnormal in physical endowment and that the children merely inherit a low-grade constitution. Thus, at every turn, we are confronted with the baffling complexity of the problems of growth.

The main argument for breast feeding is the insurance it offers against infant mortality. The artificially fed child, if it survives the first year, is usually normal in gross size, though likely to be defective in *physiological* development, as is shown by the statistics for rickets, dental defects, spinal curvatures, etc.

On the whole, we may say that that deprivation, malnutrition, etc., must be long continued in order to produce any permanent stunting effects. Minot proved that young guinea pigs temporarily starved until they were only two thirds of the normal weight for their age were able to make good almost the entire loss with return to normal diet. The same is true of temporary illnesses, which, as a rule, produce a prompt disturbance of growth later compensated by a corresponding acceleration. The fact that poverty does produce a marked and permanent stunting effect has, therefore, the greatest significance.

The evils of malnutrition are perhaps best illustrated by the effects of the hookworm disease upon the growth of children. As is well known, the disease is caused by the hookworm parasite, a small worm about a half-inch in length, which finds its way into the alimentary tract. There it attaches itself in great numbers to the walls of the intestines and feeds. By frequently attaching and detaching themselves the parasites cause hemorrhages, ulcers, thickenings and degenerations of the intestinal linings, hindering in this way the normal processes of digestion as well as causing a certain loss of blood. Children who have suffered for some time from the disease are pale, undersized, emaciated, mentally dull, and of low vitality. The number of red corpuscles may fall to 60 per cent of the normal and the hæmoglobin still lower. The liver and spleen are enlarged, and most of the other organs are affected in one way or another. The physiological development may be retarded several years, as is interestingly shown in the radiographs facing page 63. The condition in the main is one of extreme malnutrition, though it is possible that the effects are in some measure due to toxins produced by the parasite and injected into the blood. In every respect growth and development are interfered with, and to an extent proportional to the number of parasites.

Glandular influences. Normal growth is known to be conditioned by the activity of certain glands, particularly the thyroid. If the thyroid is congenitally absent or defective, cretinism results, a condition of mental defectiveness with misshapen dwarfishness of body. If treatment is begun early enough, thyroid deficiency may to a certain extent be made good by a diet including an artificial thyroid preparation made from the glands of sheep. It is possible in this way to rescue children to a normal life who otherwise would be doomed to helpless idiocy. "Within six weeks a poor, feeble-minded, toad-like caricature of humanity may be restored to mental and bodily health."[1]

To be of much avail, however, the diet must be continued from early infancy until growth is completed. Thyroid diet does not materially improve the condition of feeble-minded children other than cretins. More rarely, certain organic defects are produced by overactivity of the thyroid gland.[2]

Growth rhythms. Marked seasonal influences on growth were established by the painstaking investigation of Malling-Hansen (9), who measured the height of seventy boys daily for two years and the weight for three years. For height, the season of maximal growth extends from the end of March to the middle of August; the minimal period from August until the middle of November. For weight, the figures are almost exactly reversed, maximal growth extending from August to September and minimal growth from the end of April to the end of July. This investigation was made in Copenhagen. Data are not available to inform us how the growth rhythm in the South Temperate and Torrid zones differs from that of the North Temperate. Why children advance in height most rapidly in the spring and early summer and gain most weight in the late summer and early fall is not known, but the fact is an important one to be kept in mind by those who interpret growth

[1] Osler, *Practice of Medicine*, 1909, p. 771.

[2] Graves's Disease, sometimes treated by surgical removal of part of the thyroid gland.

records. Otherwise, regimen may get the credit or the blame for growth changes due to the earth's revolution around the sun!

It is interesting to note that the law which states that "rapid growth in height immediately precedes rapid growth in weight" holds for each individual year as well as for the pubertal acceleration. It is also significant that the rapid growth in height is in part coincident with a period of high fatiguability and mental sluggishness, while the fall period of rapid growth in weight marks a rapid rise in the seasonal curve of the power to attend.[1] Daily, weekly, and monthly rhythms have also been detected, but these are slight and of no special importance for school hygiene.

School influence. Is the influence of school life sufficient to affect growth in height and weight? The data justify an affirmative answer, particularly as regards the period immediately following school entrance.[2] That the initiation of the child into the life of the school should prove such a profound shock as to affect the growth of the entire body forcibly suggests the desirability of reforms that will make the transition from home to school more easy and natural. There is no reason why the school should be less healthful than the average home. It ought to be more healthful than the average home, and until it is made so the campaign for school reform should continue. Open-air classes point the ideal by demonstrating that it is as possible for the school to create health as to destroy it. The fact that Copenhagen children of to-day considerably outrank

[1] See chapter XX.

[2] See p. 388.

those of thirty years ago both in stature and weight [1] is evidence that medical inspection, shorter programs, school feeding, and other educational reforms have there borne fruit.

Pre-natal influences on post-natal growth and development are little known. From the evidence available it appears that overwork and underfeeding of the mother during pregnancy reduce the size of the offspring at birth and materially increase the probability of death in the first few months, but that if the early dangers are safely weathered the child will grow normally in height and weight. Paton was able to reduce the size of guinea pigs at birth 25 per cent by starving the mother during pregnancy. Newman's important work on infant mortality shows clearly that overwork during pregnancy is a frequent cause of premature birth and consequent infant mortality.

The use of alcohol by the expectant mother is commonly believed to be productive of idiocy and of various kinds of disease and deformity in the offspring. The recent researches of the Galton Eugenics Laboratory, however, give no support to this belief. On the other hand, Stockard has plainly demonstrated that parental alcoholism in guinea pigs influences both the number and healthiness of the offspring. "Forty-two matings of alcoholic guinea pigs have given only eighteen young born alive, and of these only seven, five of which are runts, survived for more than a few weeks; while nine matings of non-alcoholic guinea pigs have given seventeen young, all of which have survived and are

[1] See *School Hygiene*, 1912, pp. 175 *ff*.

normal, vigorous individuals. These facts convincingly demonstrate the detrimental effects of alcohol on the parental germ (of guinea pigs) and on the developing offspring" (11, p. 297). This is in agreement with Hodge's well-known experiments on the effects of alcohol upon dogs.

The indirect injury which alcohol works upon children by depriving them of adequate food, clothing, shelter, and education is undisputed, and we are always in danger of mistaking this indirect influence for a direct effect of alcohol upon the germ cell itself.

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14. See also Burk, Hall, Hoesch-Ernst, and other references given at the end of chapter III.

CHAPTER V

SOME PHYSIOLOGICAL DIFFERENCES BETWEEN CHILDREN AND ADULTS

General differences

EVERY organ has its own growth rate and its own critical periods of development. Measurements of height and weight give us little notion of the complexity of the processes taking place within. Judged by size alone, the child might be looked upon as like the adult, only smaller. Nothing could be farther from the truth. The child is different from the adult in every fiber, every blood corpuscle, every bone cell, and in the relative pro-

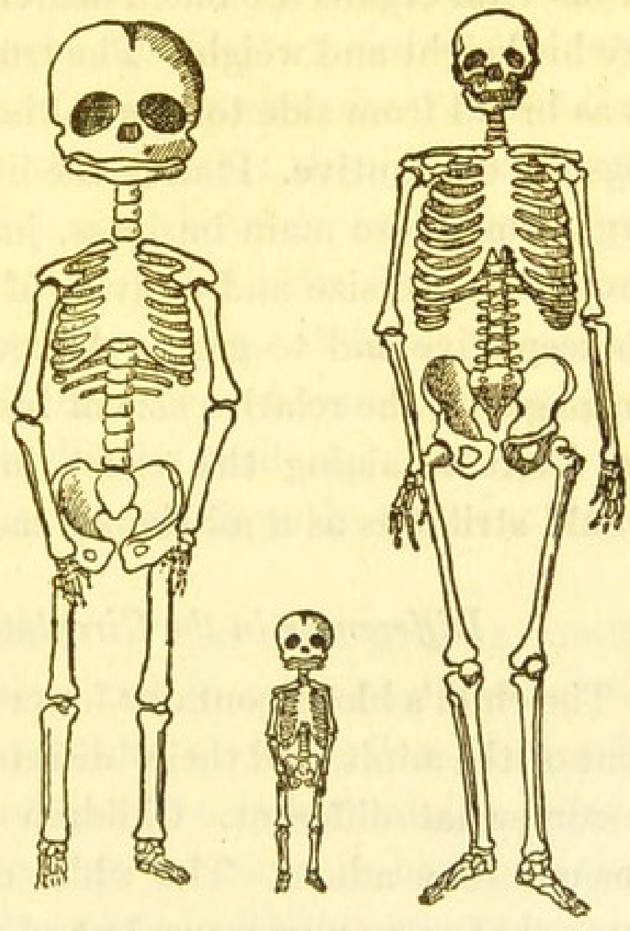

FIG. 3

This plate is specially designed to show how much the proportions of the new-born child differ from those of the adult. To make this difference more striking, the skeleton of a new-born child (A) and that of an adult (C) are here represented drawn on different scales. (B) represents the new-born child drawn on the same scale as (C). (From a photograph by Prof. Sanford published by S. Hall, Adolescence, I.) — D. Appleton & Co.

portions of all his parts. His resistance to disease, his powers of recuperation, his food and sleep requirements are all unlike those of the adult. He is differently affected by every element of environment and regimen. Child hygiene and child physiology are far from synonymous with the hygiene and physiology of the adult.

The newborn child is largely trunk and head. Most of his vital organs are much nearer the adult size than are his height and weight. The trunk is long, the head is as broad from side to side as the shoulders, and the legs are diminutive. Plainly the little child is a sessile organism whose main business, judging from the disproportionate size and activity of the vital organs, is to keep alive and to grow. As revealed in the figure on page 47, the relative size of his parts is such that an adult retaining the exact infantile proportions would strike us as a misshapen monster.

Differences in the Circulatory System

The child's blood contains fewer red corpuscles than that of the adult, and their "disintegration quotient"[1] is somewhat different. Children are more prone to anæmia than adults. The white corpuscles are in all somewhat more numerous, but of these relatively few have germicidal power. For this and other reasons the child's resistance to certain diseases is significantly inferior. As shown by Mouton, if the child contracts

[1] This term refers to the readiness with which the corpuscles yield up their oxygen to the tissues.

measles in the first year of life the chances are about one in five that he will not recover. From one to three or four years the chances of death are one to twenty-five, and if measles can be postponed until after the sixth year the probability of death is reduced to about one in two hundred and fifty. Whooping-cough is another disease which is more dangerous for the infant than typhoid fever or smallpox for the adult.

The child's heart, compared to his arteries, is small, and must beat with great rapidity to maintain the normal pressure of blood. During growth the width of the aorta increases only three times; that of the heart twelve times. The adult ratio between heart and arteries is not attained until the later years of adolescence, previous to which time all exercises and games making heavy demands on strength or endurance are dangerous. In shape, also, and in its position in the thoracic cavity, the child's heart is significantly different from the adult's.

The lymphatic system of the child plays a much greater rôle in nutrition and in resistance to disease than is true of the adult, and since the flow of lymph is so largely dependent upon muscular activity, sedentary habits are particularly injurious to health in the years of childhood. Associated with this greater activity of the lymphatic system in the early years there is a marked tendency to hypertrophy of the lymphatic tissues (adenoids, enlarged tonsils, etc.) and a special liability to disease of the lymph glands.

The digestive system

The digestive system of the child is different throughout its course from that of the adult. Dentition is not complete till adult life. The mouth glands which secrete ptyalin, the starch-changing ferment, are entirely inactive for months after birth and only gradually assume their proper functions. The child's stomach is tubular and more vertical than in the adult and has weaker peristaltic movements. The gastric secretions are functionally quite different from those of the adult in that they lack the power of dissolving the cell walls in the food and freeing the proteids. The intestines, likewise, are different in position, secretions, functions, and relative size. The liver at birth is one eighteenth the size of the body, while with the adult, it is one thirty-sixth the size of the body.

Metabolism is far more rapid in children than in adults. A child of three years requires 40 per cent as much food as the adult, though the size of the body is less than 20 per cent as great. Because the surfaces of similar solids compare as the *squares* and their bulk as the *cubes* of their linear dimensions, it comes about that the child of 6 has about 60 per cent more body surface in proportion to weight than has the adult. This involves far more rapid heat loss and necessitates relatively greater heat production. The infant consumes from four to five times as much oxygen as the adult per unit of weight, and the child of 6 years about twice as much. The amount of carbon dioxide exhaled is correspondingly greater.

It is not strange, therefore, that any disturbance of the factors which influence metabolism, such as insufficient food, deprivation from exercise, lack of fresh air, etc., produce their ill effects upon the child more quickly than upon the adult. The child's reserve of energy is small; his fatiguability is high; he is quickly brought to exhaustion. This is as true for the brain as for the muscles. For the younger school child, short periods of work should alternate with short periods of rest. Two- and three-hour school sessions without rest are always unhygienic for young children, possibly also for older ones. We have only to watch the rapid and spontaneous alternations of activities in children's unsupervised play to find the law which should serve as the fundamental guide in the making of all school programs.

The respiratory system

Lung capacity follows closely the curve of weight, and is therefore a valuable index of vitality. The ratio between lung capacity and weight is called the "vital index." De Busk (3) finds the vital index smaller for children below grade than for children not retarded. Although from 11 to 14 years, girls exceed boys in height and weight, they fall below boys in lung capacity at every age. This is probably due, in part, to the sedentary and indoor life led by girls, and is very important when considered in relation to the excessive mortality of adolescent girls from tuberculosis and their tendency to anæmia. Girls of primitive races, and American and European girls who live in the country, approach more nearly to the average vital capacity of their brothers. The fact that girls breathe more with the upper part of the chest than do boys is traceable in some degree to dress and sedentary habits, in part to structural causes. Exercise and habits of breathing both have an astonishing influence on vital capacity, which has been known to increase as much as three hundred cubic centimeters in three months. Deep breathing helps to determine the rate of oxidation of the blood, but is less a factor in this than exercise.

The size of the lungs, however, is probably less related to health than is their right use. The chief danger lies in harboring unused lung tissue. The importance of right lung development and the cultivation during childhood and adolescence of right habits of breathing and exercise can hardly be overestimated. The fate of those who have a tendency to tuberculosis is usually sealed before the close of the adolescent period. Smedley found a direct correlation between vital capacity and school progress.[1]

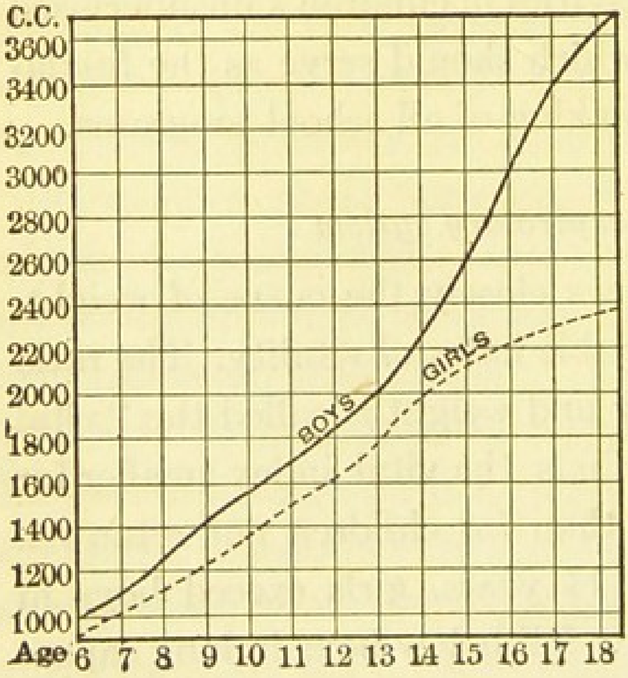

FIG. 4
Showing increase in lung capacity. (From Smedley's table.)

[1] For relation of vital capacity to nasal obstructions see chapter XII.

The accompanying curve, based on Smedley's Chicago study, gives the norms of vital capacity for the ages 6 to 18.

The muscular system

On the laws of muscular development, if the related facts were fully at our command, an entire philosophy of education could be based. The child's muscles, individually and collectively, differ from those of the adult in accuracy, strength per unit of cross-section, bilateral symmetry, ability to take on training, delicacy of coördinations, etc. The muscular system of the newborn child is 23.4 per cent of the weight of the entire body, that of the adult, 43 per cent. Moreover, the child's muscles contain relatively a much greater proportion of water, and are even more inferior in function than in size or weight.

The order of development for individual muscles and sets of muscles is of greater significance for hygiene than their growth considered *en masse*. The well-known law, that voluntary control (for both rate and accuracy) of the "fundamental" muscles develops before that of the "accessory," has immediate and obvious application in manual and industrial training, drawing, writing, play instruction, gymnastics, sports, and in the arrangement of the school program. Plays, manual exercises, or instruction of any kind demanding delicate coördinations of the accessory muscles (the fingers and hands, for example) should have no place in the kindergarten and need to be subordinated in the first two or three years of the grades. Excessive employment of the accessory muscles, to the neglect of the fundamental, often gives rise to symptoms of nervousness such as those associated with morbid precocity. The modern school program, with its over-use of the muscles of the eye in reading and of the hand in writing, coupled with the still more injurious neglect of the large muscles of the arms, trunk, and legs, constitutes a universal menace to healthy growth. Children's bodies, in every bone, muscle, and vital organ, are likely to suffer in their development from the sedentary regimen of the school.

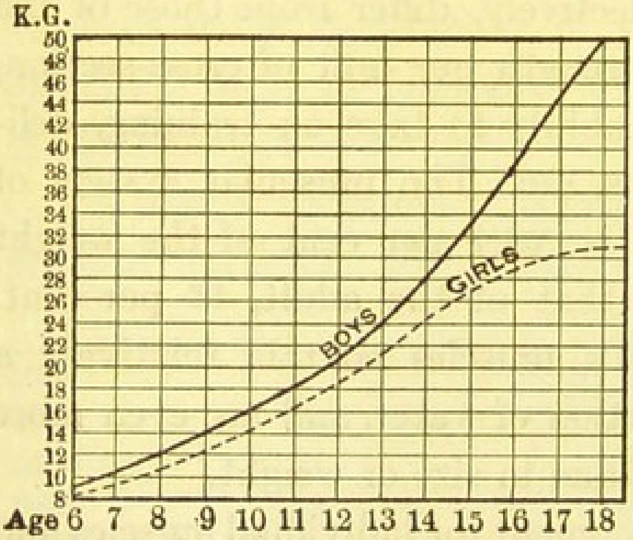

FIG. 5
Showing increase in strength of grip for right hand. (From Smedley's table.)

Growth norms of muscular strength, as measured by power of grip, are shown in the accompanying curves from Smedley.

The reader should be reminded that the various muscles of the legs, back, shoulders, etc., have curves of growth in strength entirely peculiar to themselves, and that the curves for strength do not parallel even approximately those for accuracy and speed. All of this is set forth clearly in the admirable summary to be found in Hall's *Adolescence*.

In general, boys excel girls in strength (relative to weight); also in speed and accuracy as measured by the usual tests. In strength of grip, American girls fall further below the average for boys than do the Philippine girls.

Attempts to correlate motor functions with intelligence in normal children have given widely contradictory results, but the feeble-minded as a class are decidedly inferior to normal children in strength of grip, rate of tapping, accuracy in tracing complex figures with a pencil, and in the coördinations requisite for the usual school work in manual training. Backward children are especially retarded and uncertain in developing control of the accessory muscles.

Much has been written about the hygienic aspects of our system of unidextrous education, some hygienists believing that our comparative neglect of one half of the body involves certain dangers to health and even to brain growth. Unidexterity certainly tends to produce bilateral asymmetry, to favor one lung at the expense of the other, and to bring about lateral curvatures of the spine. Indirectly, through the posture, the eyes also may be influenced. But the advantages of specialization are so great that proposals to cultivate perfect ambidexterity in all children cannot be taken seriously. The backward and feeble-minded are less often unidextrous than normal children. This is due chiefly to relatively lower development of control of the right side, so that the feeble-minded may be said to have, in effect, two left hands.

The skeletal system

As regards the development of the skeletal system, the fact of greatest significance for hygiene is the extreme slowness with which ossification takes place and the consequent possibility of deformity from incorrect posture, lack of exercise, etc., during the growth period. Much that is rigid bone in the adult is soft cartilage in the child, and the whole skeletal system of the latter is plastic to a degree which is rarely appreciated.[1] The ossification of the jaws is not complete till some time after puberty, so that severe deformities of the lower part of the face may be caused or cured up to this time. The shape of the entire head and the proportions of all its parts continue to undergo marked transformation till well toward the close of adolescence. Even the orbit of the eye assumes its final shape only gradually, so that the younger children are prone to hyperopia and older ones to myopia.[2]

In the child there is a suture in the roof of the middle ear which permits easy connection by blood vessels between the middle ear and the dura mater membrane covering the brain. This helps to explain the frequency with which mastoid complications arise in the case of middle-ear infections with children. Associated with this is the fact that the child's ear is relatively closer to the throat than the adult's, and that the eustachian tube, which forms the connection, is straighter and wider, both relatively and absolutely. It is because of this short, straight, and broad road from the throat to

[1] See chapter VII. [2] See chapter XIV.

the middle ear that throat infections in children make the journey so readily.[1]

The nervous system

Compared to the rest of the body, the central nervous system shows a precocious growth in size and weight. At birth the brain has already attained about one fourth of its final size, and by 7 years over 90 per cent. Growth continues much retarded up to about 14, and then practically ceases. But here, least of all, does weight give any idea as to maturity. The cells of the brain, though all present in embryonic, granule form for several months preceding birth, only gradually ripen into their fully differentiated structure and put forth their branching network of dendrites. So unripe is the brain at birth that the neural functioning of the newborn child may be compared with that of Golz's dogs whose brains had been removed. Only the raw, instinctive reflexes are present.

The acquisition of the medullary sheath, which we have above spoken of as the ripening process, proceeds rapidly in the sensory and motor centers and more gradually in the frontal portion, named by Flechsig the "association centers." This includes almost two thirds of the cerebral cortex, which, together with the middle sheath of tangential fibers, shows remarkable and important changes in the cellular development of later

[1] The most common diseases of the bones during childhood, rickets and tuberculosis, are discussed elsewhere. See pages 79 and 129.

adolescence, the changes continuing probably as late as 40 years. That this is coincident with an equally marked intellectual growth suggests the futility of the premature culture of rationality and the highest ethical traits of character. The lack of judgment, the irresponsibility, and the mental unripeness of youth have a more material basis than the mere lack of experience. Developed brain cells are necessary and a rich network of connections.

Again we see how growth is capable of solving some of the most difficult pedagogical problems. We cannot teach little children to sit still, and should not if we could; but if we will only wait till those higher centers have developed which make voluntary inhibition possible, we shall find our pedagogical problem has vanished. The youth can sit still without being taught. Only a little patience is necessary to dispose of many another pedagogical dilemma in the same way.

But time alone does not suffice. Brain centers which are little used do not develop normally. The visual and auditory centers of Laura Bridgman's brain were found, after her death, to be in the infantile, unripe condition; small, granular, primitive cells with few branches. The development of the brain is fostered best by a play life which is rich and varied and by educational exercises suited to its stage of immaturity. The use of the brain in varied physical and mental activities improves its circulation, its nutritional processes, and therefore its finer development and highest functioning. Probably also it delays the degenerative processes of old age, for senescence, unfortunately, does not leave the brain unaffected.

After 50 or 60, the weight materially decreases, the neuroglia — the supporting, non-nervous connective tissue — encroaches more and more upon the domains of the nervous tissue proper, and the cells of the latter become heavily pigmented and shrunken like the ganglion cells of a frog which have been electrically stimulated to the point of exhaustion.[1] Many of the cells even disintegrate and are carried off as waste products. The processes of decay seem to occur late in the life of the mental worker and prematurely in those whose labor is mostly physical. This, coupled with the fact that cerebral development continues well on into middle life, is an added argument for the establishment of educational institutions for adults; likewise for such alterations of social and industrial institutions as will enrich in any degree the intellectual life of those whose work is not predominantly mental.

Lack of harmony and regularity in growth

Growth throughout the body, whether we compare the organs of different systems or different parts of the same system of tissues, progresses with the greatest irregularity. Wherever we look we fail to find any such thing as an even, regular, harmonious growth. The heart follows a curve different from that of the arteries, the muscles of the leg different from those of the forearm, the bone of the upper leg different from those of

[1] See reference 4, chapter XVII.

the lower, etc. As stated by Hall, every organ has its own growth inning. A good illustration is the comparison between the growth of trunk and legs. In the first triennium the trunk's percentage increment for length is two thirds that of the legs; in the second triennium, one half; in the third triennium, one fourth; and in the fourth triennium, again one half. The excessive growth of the legs from nine to twelve years is not only destructive of bodily grace, but may act as a drain and tax upon the activity of the heart and other organs.

Most impressive also is the lack of permanency in the form, structures, and functions of the child's organs. From first to last, developmental changes are more important than those of mere growth. It is unsafe, *a priori*, to infer that anything which is safe or beneficial for the adult is hygienic for the child. Child hygiene, we may repeat, in both its mental and its physical aspects, must be cultivated as a distinct and separate field.

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CHAPTER VI

THE EDUCATIONAL SIGNIFICANCE OF "PHYSIOLOGICAL AGE"

Distinction between chronological, anatomical and physiological ages

THE reader is already familiar with the fact that not all children of a given age are equally advanced in a physiological sense. The number of years a child has lived we may designate as his "chronological age." In contradistinction to this, the stage of maturity which the child has attained may be designated his "physiological age." The term "anatomical age" is sometimes used in reference to the successive stages in the anatomical development of the individual.

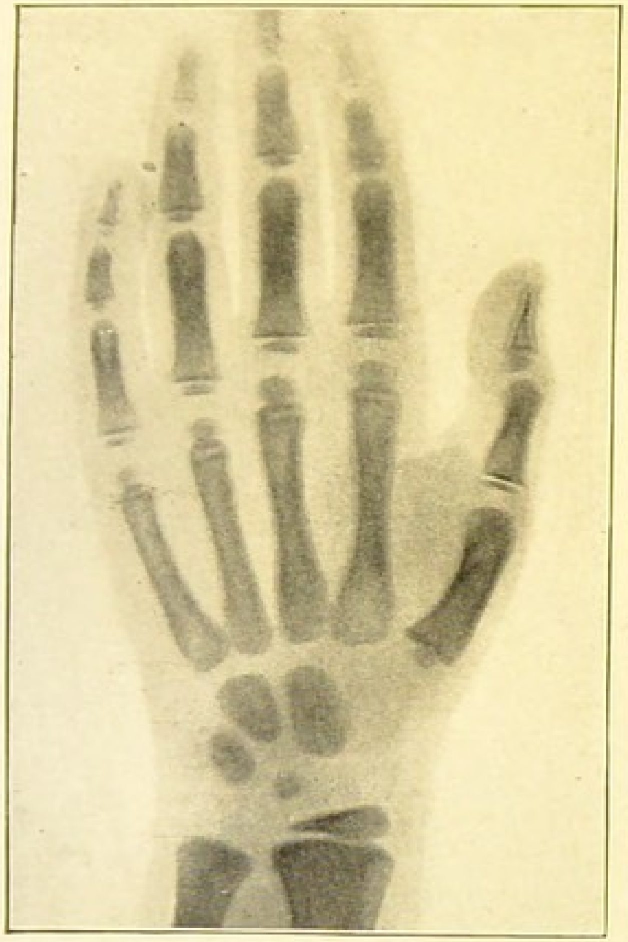
It is well to keep clearly in mind this distinction between chronological age, on the one hand, and physiological or anatomical age, on the other. These run by no means a parallel course. A boy who has lived sixteen years may be no more mature, physiologically, than another who has lived only twelve. Differences in physiological age amounting to two or three years are extremely common in children of the same chronological age. Given a miscellaneous group of boys whose chronological ages all fall within one month of fourteen years, there are likely to be some in the group who are two years past the age of puberty and others who will not become pubescent for two or three years. For medical, pedagogical, industrial, and social reasons it is sometimes more important to know the physiological age than the chronological.

For opening up the field in a definite way we are indebted chiefly to two important and painstaking investigations: (1) that of Rotch and Pryor on the anatomical stages in skeletal development, and (2) Crampton's study of physiological development as marked by pubescence and dentition.

Anatomical age

In studying the process of ossification by means of the Roentgen rays, Rotch and Pryor found well-defined stages in the transformation of cartilaginous tissue into osseous. These stages always succeeded each other in the same order. The stages appeared most clearly in the carpal bones and the epiphyses of the hand and wrist. Following this suggestive clue, Rotch made radiographs, or X-ray pictures, of the wrists of two hundred normal children of all ages from birth to 14 years. From an analysis of the results he marked off thirteen stages of anatomical development which he designated by the letters A, B, C, D, etc. These constitute in effect a scale of norms, empirically derived, by reference to which we may judge the degree of anatomical development which any given child has attained. An idea of the scale may be gained by an examination of the plates facing this page.

Rotch finds that anatomical development proceeds



GIRL, AGED THREE AND ONE HALF YEARS

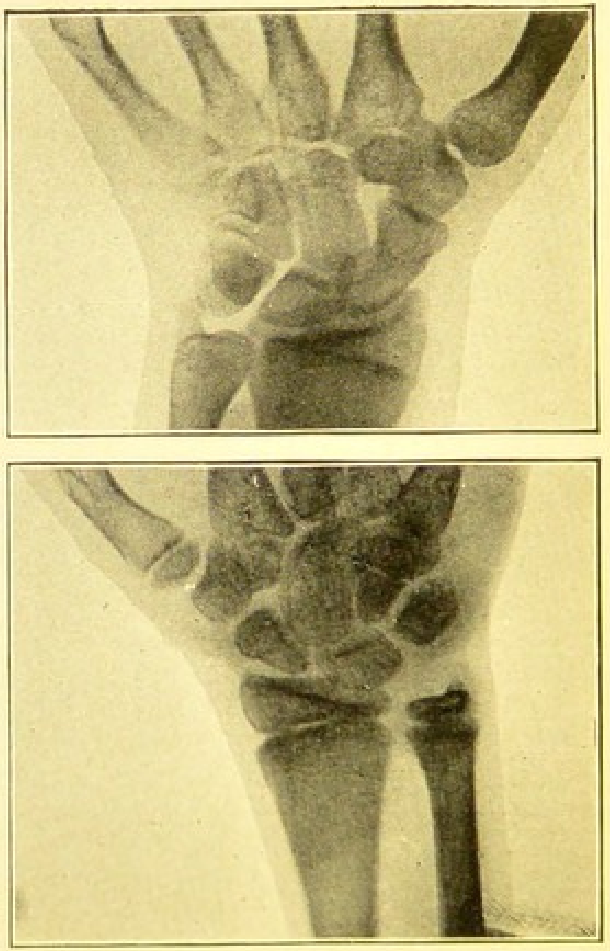
GIRL, AGED SIX YEARS

GIRL, AGED TWELVE AND THREE QUARTERS YEARS

These radiographs, and also those on the next page, are from negatives by Dr. Thomas Morgan Rotch, originally reproduced in the "Transactions of The Association of American Physicians."

I. GIRL, AGED FIVE YEARS AND THREE WEEKS. Twin sister of boy, Plate II.

II. BOY, AGED FIVE YEARS AND THREE WEEKS. Twin brother of girl, Plate I.



Above. 15-YEAR-OLD BOY WHO ENTERED COLLEGE AT 11 YEARS AND GRADUATED WITH HONORS AT 15.

Below. 15-YEAR-OLD BOY, HOOKWORM VICTIM.

Note that the latter shows retarded ossification as compared with the former.

largely independently of height, weight, or chronological age. A 12-year-old child may have a bone development corresponding to that of the average 10-year-old, and two 10-year-old boys of equal size may show a significant divergence in skeletal maturity. Size and real age tell us nothing about a child's anatomical age. Rotch presents radiographs of the wrists of three boys, aged 7, 8 and 9 years respectively, who are of exactly equal skeletal maturity.

Another important point established by Rotch is that girls are more advanced than boys at every age as regards epiphyseal development. This is very different from that which obtains for height and weight, in which traits girls excel boys only from the ages 11 to 14. From the plates facing this page we see how much more advanced in anatomical age a girl of 5 years may be than her *twin* brother. Twins of the same sex, however, always show the same grade of anatomical maturity.

Diseases which involve disturbances of nutrition influence anatomical and physiological maturity much more than they affect height or weight. The effect of the hookworm disease is shown in another of the plates facing this page.

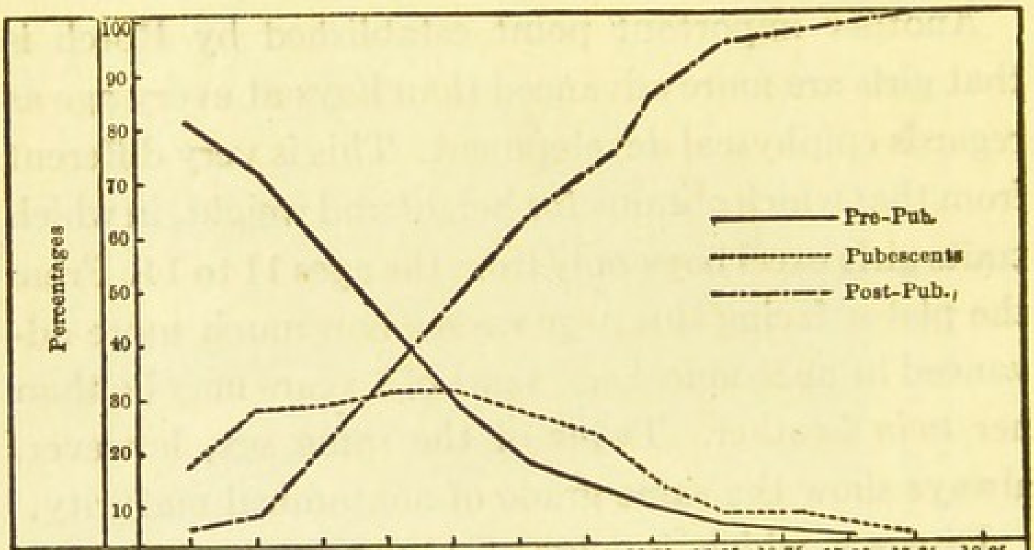
Physiological age

The differences which have been discovered in physiological, or functional, maturity corroborate in a striking way the findings of Rotch and Pryor. For five years Crampton collected data on the age at which the various stages of pubescence [1] appeared in high-school

[1] Three fairly definite stages were determined.

boys of New York City. These he correlated with measurements of height, weight, grip, and school success. Records were secured from 3835 boys of all ages, grades, and social classes represented in the schools.

The results show astonishing differences of physiological maturity in boys of the same chronological age and the same school class. The average high-school class, particularly in the first three grades, is a mixture of pre-pubescents, pubescents (those who are under-



Age Group	12.25	12.75	13.25	13.75	14.25	14.75	15.25	15.75	16.25	16.75	17.25	17.75	18.25
Pre-Pub.%	(81)	69	55	41	26	16	9	5	2	1	0	0	0
Pubescents%	(16)	25	26	28	28	24	20	10	4	4	2	0	0
Post-Pub.%	(2)	6	18	31	46	60	70	85	93	95	98	100	100

FIG. 6

Percentage of each Pubescence Sub-Group for each Half-Year Group. — Crampton, *American Physical Education Review*, March, 1908.

going the pubescent transition, which lasts usually from five to seven months), and post-pubescents. The fundamentally important question which Crampton raises is whether the instruction meted out to such a non-homogeneous group can possibly be fitted to the intellectual interests, the moral standards, the æsthetic appreciations, or the mental and physical endurance of each individual pupil.

The distribution of the three stages of pubertal development in Crampton's 3835 boys is shown in Fig. 6.

The above curves show that 17 per cent of the boys whose ages fall between 12 and $12\frac{1}{2}$ years have already entered upon the pubertal transition, and that by 14 years the number has increased to 70 per cent. Further, that about 4 per cent of the boys have completed the transition by $12\frac{1}{4}$ years, and by $15\frac{3}{4}$ years, about 80 per cent. At $13\frac{3}{4}$ years, or about the beginning of the high-school period, the number of pre-pubescents, pubescents, and post-pubescents is almost exactly equal.

The second principle established by Crampton is that height, weight, and strength correlate much more closely with physiological than with chronological age. Boys of 14 years, for example, are tall or short, heavy or light, strong or weak, according as they have or have not reached pubescence. This is shown in the following significant tables: —

TABLE 5

Weight according to physiological age (kilograms)

Age in years	Pre-pub.	Pub.	Post-pub.
13–14	34.9	37.7	43.9
14–15	35.7	38.7	46.3
15–16	37.5	39.5	48.5

TABLE 6

Weight of $14\frac{1}{2}$ to 15 year boys according to maturity

Pre-pubescents	36.76 kilograms
Pubescents	38.86
Post-pubescents	47.21

The results are similar to the above for height and strength. We may say, therefore, that boys of 13 who are post-pubescent resemble in height, weight, and strength post-pubescent boys of 15 or 16 much more closely than they resemble pre-pubescent boys of their own chronological age. In deciding the boy's fitness for a given athletic sport, or for a certificate permitting him to leave school to work in a mill, or even for instruction of a given grade, the crucial question is not how long he has lived, but how far he has proceeded toward maturity. Furthermore, in judging the growth status of an individual boy the question is not whether he is as tall, as heavy, or as muscular as the mathematical average of boys in general for his age, but whether he has reached the physical standard which his own actual degree of maturity calls for.

Scholarship, also, seems to be correlated with degree of maturity. Young pupils who have reached an advanced grade are likely to be found post-pubescent, while old pupils in the lowest grade are often pre-pubescent. Of the 14 to 14½-year-old boys in the first term (each year is divided into two terms), 42.9 per cent are pre-pubescent, while of boys of the same age who have reached the fourth and fifth terms, only 16.7 per cent are pre-pubescent; 68.2 per cent of the 13 to 13½ year boys in the first term are pre-pubescent, as against 30 per cent of the same age group who have reached the third term. Again, when the percentage of failures was calculated for each age according to degree of maturity it was found that 50 per cent more of the pre-pubescent 13-year-old boys "failed" than of post-pubescent 13-year-olds. The corresponding difference for 14 years was 41 per cent, and for 15 years, 24 per cent.

Crampton was able to demonstrate what previous statistics had indicated but not established; namely, that the later the pubescent transition arrives the more rapidly it is hurried through. The speed of transition from pre- to post-pubescence was also found to be much more rapid in summer than in winter, a fact which demands reinterpretation of such data as those of Malling-Hansen on seasonal variations in growth.

In a preliminary investigation of physiological age differences among high-school girls, Crampton found the same relation of physiological age to height, weight, and strength as obtained for boys.

Finally, in a third investigation of dentition among 934 pupils of the elementary schools, Crampton finds a similar correlation of weight, height, and strength with the number of permanent teeth which have erupted. If further data should confirm this, dentition would be found the most serviceable index of physiological maturity, both because of the ease with which observations may be taken and because of the long period through which the changes may be noted.

Conclusions

The importance of the distinction between physiological age and chronological age is obvious. We have lately awakened to the fact that each year one child in six or seven fails of promotion; that the large majority drop out before reaching the high school; that the wholesale elimination involves boys to a greater extent than girls; that girls of a given age make better marks in their class work and in examinations than boys of the same age; that many weakly pupils break down in the effort to keep up with the class in which their chronological age places them; — that education from bottom to top needs more than anything else to be individualized.

It is easy enough to say that this should be our ideal; but *how* to suit the instruction to the individual child is anything but easy. The value of such investigations as those cited above lies in the suggestions they offer in this line. They show that children of the same age vary more in maturity than we have ever suspected, and that, although the differences are accentuated at early adolescence, they are often very marked in childhood. They suggest that girls may possibly be as ripe for school at 5 years as boys are at 6, and that they normally reach the high-school age some two years ahead of their brothers. The entire problem of the identical co-education of the sexes will have to be reviewed in the light of this fundamental physiological fact.

The investigations suggest that determinations of physiological and anatomical age by the Roentgen method, or some other, might well be invoked to help decide doubtful cases of promotion. For example, let us imagine two girls in a fourth-grade class who are a little slow in their work and about the advisability of whose year-end promotion the teacher is in some doubt. Both pupils, let us say, are not so low in their marks but that they might be expected, with considerable extra effort, to carry the work of the following grade if promoted. But would it be wise to have the child risk the extra effort this would require? We cannot answer this question on the basis of weight, height, grip, or the presence or absence of external physical defectiveness. But if radiographs should reveal that one of the girls is a year ahead of her age in the physiological development and that the other is a year in retard, there would then be little doubt about the wisdom of risking promotion in the former case and denying it in the latter. A few years hence may see the installation of the Roentgen apparatus in the hygiene departments of all cities where school medical supervision is practiced. The purpose of such work would not be merely that of holding back the weak and immature to save them from over-pressure; it would be equally concerned about permitting those of advanced development to profit by the advantage of maturity with which nature has endowed them.

It is well to emphasize, however, that we do not yet know the precise degree to which either pubertal or skeletal development is correlated with brain development or with vitality. The relation seems to be, on the whole, a fairly constant one, although Rotch himself admits possible discrepancies.

Closer investigation of the relations existing between the anatomical, physiological, and mental ages is one of the urgent problems of educational hygiene. We want to know what the best index of general development is. Theoretically, Rotch's method would seem to offer the best approach, since skeletal development is probably much less influenced by accidental circumstances of training, exercise, environment, etc., than are the various physiological functions. Yet nothing may safely be taken for granted in dealing with matters as complicated as growth phenomena are known to be.

When reliable standards for determining developmental stages have been worked out they can be put to immediate use in diagnosing athletic fitness, in vocational guidance, in the classification of pupils for manual work and gymnastic training, etc., as well as in problems relating to gradation for purposes of instruction. Society has no moral right to turn over the weakly immature child of 14 to the overtaxing work of mill and factory on the mere basis of so many years lived.

Other problems which suggest themselves are the bearing of physiological age differences on moral education, procedure in criminal law, the relative value of male and female teachers for various school grades, the advisability of instituting the intermediate high school, etc. In the light of the well-known changes wrought by adolescence in the child's interests, and the complete transvaluation which then becomes apparent in his attitude toward social and moral questions, we may well ask whether the same instruction can ever be suited to the needs of both pre- and post-pubescents whom our educational lockstep so frequently chains together.

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CHAPTER VII

DISORDERS OF GROWTH AND THE HYGIENE OF POSTURE

Written with the assistance of Dr. E. B. Hoag

Disorders of growth affect chiefly the bony skeleton and the muscles which support and propel the body. The defects most commonly observed may be classified as follows: —

A. Curvatures of the spine.
   1. Kyphosis. (Outward curvature: round back.)
   2. Lordosis. (Inward curvature.)
   3. Scoliosis. (Lateral curvature.)

B. Other deformities.
   1. Pigeon-breast.
   2. Knock-knee and bow-legs.
   3. Flat-foot.

The human race in the course of evolution has only imperfectly adapted itself to the upright posture. For this reason, chiefly, deformities of the vertebral column, pelvis, and legs are relatively common, since these are the structures most affected by the shifting of the center of gravity which was brought about by the assumption of the upright posture. Naturally, the influence is greater during the early periods of life when the tissues are soft and subject to various nutritional disturbances. The diseases which are particularly likely to affect the nutrition and growth of the building material of the body during the rapid period of growth are rickets and tuberculosis.

Spinal curvature

Spinal curvature ranks with eye defects as one of the most common abnormalities found among school children. It is safe to say that from 20 to 30 per cent of the entire enrollment are affected, or between four and five million in the schools of the United States. When the slighter departures from symmetry are included, the number runs very much higher. Probably as many as 3 to 5 per cent have spinal curvature in a form severe enough to menace general health.

One of the best studies is that of Scholder, Weith, and Combe of 2314 school children of Lausanne. This showed 24.6 per cent with lateral curvature, 5.8 per cent with kyphosis or lordosis, and about 24 per cent with flat-foot. In the case of 11.24 per cent, the lateral curvature amounted to a spinal displacement of one centimeter or more. There was little difference between girls and boys.

Dr. Canavan found the following deformities among 2333 supposedly normal women students of Wellesley College: —

TABLE 7

Percentages of orthopedic defects

1. Back, curvature	35 per cent
2. Shoulders, uneven	53
3. Hips, uneven	43½
4. Legs	
(a) Knock-kneed	21

(b) Bow-leg .... $8\frac{1}{2}$ per cent
(c) Unequal .... $\frac{4}{5}$
5. Ankles pronated .... $70\frac{1}{2}$
6. Longitudinal arches
(a) Flat 12
(b) High 5
7. Anterior arches, flat .... $11\frac{1}{2}$
8. Toe joints enlarged .... $3\frac{1}{2}$

The results of other important investigations are presented in the following table: —

TABLE 8

Author	Place	Number of children	Spinal curvatures of all kinds		
			Boys	Girls	Total
Krug	Dresden	1418	26%	22.5%	25 %
Hagman . . .	Moscow	1664 girls	—	29	
Kallbach . . .	St. Petersburg	2333 girls	—	26	
Key	Stockholm	3000	—	—	10.8
Guillaume . .	Neuchatel	731	18	41	29
Silfwerskiold .	—	7234 girls	—	9.9	17
Bruner . . .	—	1081 boys	17.1 according to age		
R. T. Mackenzie	Toronto	160 high-school girls	—	19 (scoliosis alone)	
R. T. Mackenzie	Toronto	200 college boys	24 (scoliosis alone)		
R. T. Mackenzie	Toronto	446 college athletes	19 (scoliosis alone)		
Miss Campbell	London	High-school girls	—	22.8 (scoliosis alone)	

One should be careful, however, to distinguish between true spinal curvature and a mere faulty attitude due to carelessness or to uncertainty of posture. In young children under ten the muscles are sometimes so weak that there is not sufficient muscular control to keep the spine rigid, in which event it often exhibits a convex curve to the right or left. Permanent curvature is designated as "fixed" or "anatomical," to distinguish it from the "postural" or "functional." Probably in less than half of the cases listed as spinal curvature has actual deformity of the bones taken place, and in not all of these is displacement sufficient to produce serious injury.

Spinal curvatures sometimes begin in early childhood, but more frequently between school entrance and puberty. Of 1000 cases analyzed by Roth, 89.7 per cent first became evident between 5 and 17 years, and 59.4 per cent between 10 and 15. Silfwerskiold finds 10 per cent affected in the first grade; the number rising to 17 per cent in the fourth grade; then dropping to 9.9 per cent. The Lausanne investigation gave the following distribution according to age: —

TABLE 9

	Boys	Girls
8 years	7.8	9.7
9	16.7	20.1
10	18.3	21.8
11	24.2	30.8
12	27.1	30.2
13	26.3	37.7

Kyphosis (outward curvature of the spine)

This condition presents a round back, and involves part or all of the vertebral column. Sometimes there is a sharp angle formed, especially in Pott's disease. The region usually involved is the dorso-lumbar. The condition is most common in young rickety children, although it may occur in later life as the result, usually, of tuberculosis. The common form of kyphosis found in school children is known as "round shoulders." In this the outward curve is usually most pronounced in the middle of the dorsal part of the spine.

Usually from 5 to 10 per cent of school children have round shoulders. The principal cause is muscular weakness which allows the spinal column in this region to bend outward, the pelvis to drop backward (lowering of the posterior part of the pelvis), and the shoulders to drop forward and downward. It is easier for the weak child to assume the positions described than to maintain the normal posture, and he does so with the result that kyphosis becomes permanently established.

Muscular inactivity is the most important factor in the causation of round shoulders, and in treatment the chief aim should be to strengthen the muscles of the shoulders, back, and pelvis by appropriate gymnastic exercises.

Simple exercises for the correction of kyphosis

(1) Bending the trunk forward and backward.

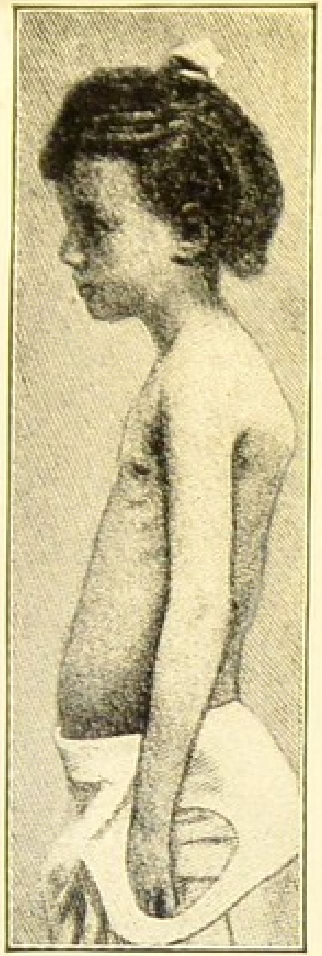
(2) Breathing exercises.

Standing in an erect position the child forces the air out of the lungs and at the same time the arms are brought forward. The arms are then gradually carried backward, while at the same time the child rises on his toes and takes a long breath.

(3) Walking exercises.

These should be taken with special attention to the proper erect posture, the hips retracted, the shoulders back, and the chin elevated.

Exercises with pulley weights while the child is seated



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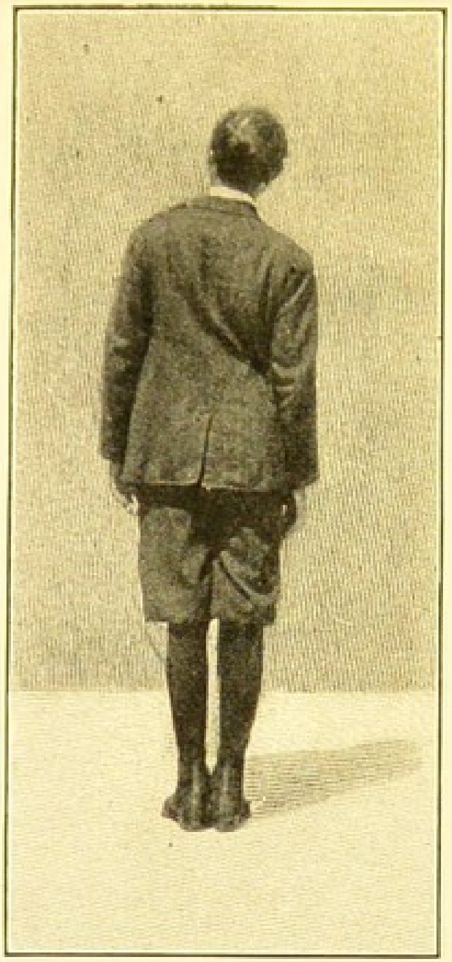

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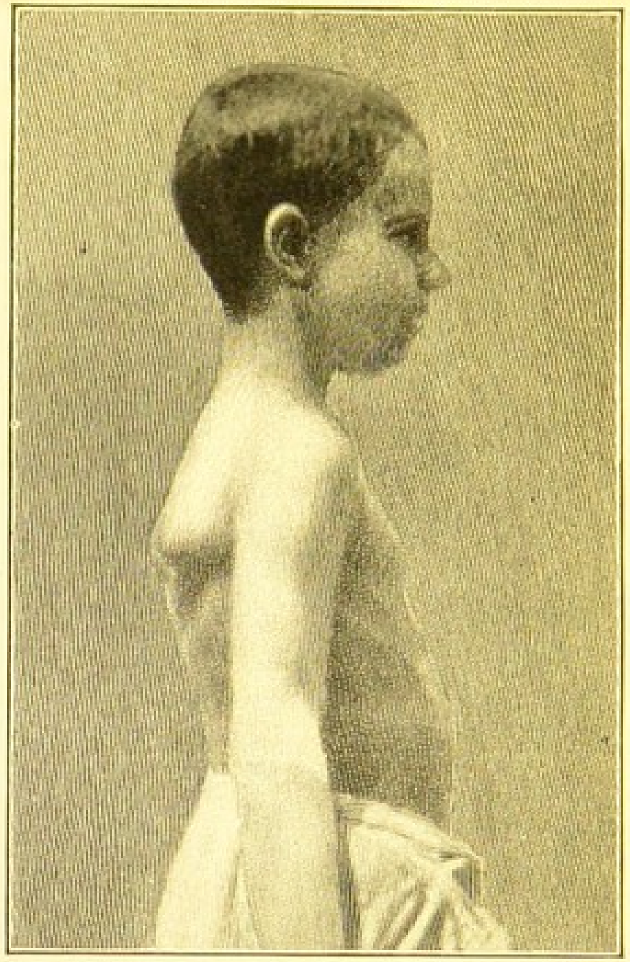


III

I. ROUND SHOULDERS. (Goldthwait.) From Pyle's, "Personal Hygiene," by permission of The W. B. Saunders Company, Phila.

II. LATERAL CURVATURE. This may often be observed through the clothing. Note low shoulder and wrinkling of coat.

III. "WING" SHOULDER BLADES IN FORWARD SHOULDERS. These can easily be felt through the clothing. Plates II and III are from Bancroft's "Posture of School Children," by permission of The Macmillan Company, New York.

at a distance of about three feet are also useful. Massage is excellent, and vigorous outdoor exercise is indispensable.

The use of braces in cases of round shoulders should nearly always be avoided. No ordinary commercial shoulder brace is reliable, and every such brace restrains the action of the muscles. No brace of any description ought to be used without the advice of an orthopedic surgeon. The latter will rarely prescribe one except under special and unusual conditions. What the back and pelvic muscles need is not restriction but increased exercise and activity.

Lordosis (inward curvature of the spine)

This deformity is not met so often in school children as kyphosis and lateral curvatures. It is caused usually by some form of hip-joint disease or by dislocation. The spinal column in lordosis curves inward. The correction consists in the discovery and removal of the cause, and for this purpose the advice of a skilled surgeon is always necessary.

Scoliosis (lateral curvature of the spine)

Lateral curvatures may be single (to one side or the other), or there may be two or three lateral curves. The single curvatures are found most frequently in young children of about 4 to 8 years of age. "Lateral compensatory curvatures appear usually at the upper or lower end of the primary curvature." Lateral curvature not only affects the spine, but also the trunk; consequently the hip projects on the concave side (high hip). The shoulder on the same side is usually held higher than the other (high shoulder).

Injuries produced by spinal curvature

The significance of spinal curvatures does not lie chiefly in its interference with the beauty and symmetry of the body, although this is a matter well worthy of our consideration. In severe cases the crowding and displacement of internal organs may affect unfavorably the general health of the body. The organs most concerned are the lungs and heart. The crowded portions of the lungs fail to develop, and susceptibility to pulmonary tuberculosis is increased. Affections of the apices (usually the right apex) of the lungs have been found in as high as 73 per cent of scoliotic patients. Adhesions of the pleura are a frequent result. The heart is "pushed upward and pressed against the anterior chest wall." Since the breathing is superficial, the heart must push a larger amount of blood through the lungs in order to secure for the body an adequate supply of oxygen. This extra demand on the heart results often in its hypertrophy. The course of the aorta is somewhat altered and the blood pressure undergoes changes. The contents of the abdomen are crowded downward, and the transverse colon may become almost vertical. The liver, kidneys, spleen, and stomach all suffer displacement, often with consequent injury to health.[1]

As regards the relation of the school to spinal cur-

[1] See reference 11, pp. 89–90.

vature, expert opinion has undergone a radical change in recent years. Noting the fact that a large majority of cases develop between the ages 6 to 14 years, and coupling this with the undeniable frequency of incorrect postures in the school, authorities were formerly inclined to lay the blame mostly upon school life. Later studies, however, show that the fundamental cause of nearly all severe spinal deformities is to be found in an abnormal or diseased condition of the bones. Incorrect postural habits are an aggravating factor and may cause minor curvatures, but they are seldom, if ever, the sole cause of grave deformity. These are often present in children who have never attended school. Nevertheless it is the duty of the school to do everything in its power to prevent the development of the defect in children who are predisposed to it. This is possible in various ways.

The most frequent cause of osseous deformity is rickets. This disease is a special form of infant malnutrition affecting chiefly the bones. The age of onset is generally between 6 months and 2 years. If severe, most of the bones may be affected. The head becomes overgrown, the joints large, the ribs are often "beaded," and the bones of the legs and trunk may become distorted under the weight of the body (bow-legs, knock-knees, etc.).

The disease occurs among all classes, but is more common among the poor of large cities. Gilmour's study of rickets among 6470 English children showed the following relation to housing conditions: —

TABLE 10

Percentage of children living in houses of	1 room	2 rooms	3 rooms	4 rooms
Rickety children........	13.4	65.8	18.	2.8
Non-rickety children....	9.5	56.9	20.3	13.2

Gilmour found evidence of rickets with 23.16 per cent of school boys 5 to 14 years of age, and with 12.05 per cent of the girls. It is safe to say that in any school population, not far from 10 per cent have been affected. It is this fact, chiefly, which accounts for the prevalence of spinal curvature, knock-knees, bow-legs, pigeon-breast, etc.

The mental condition of rickety children averages slightly below par, as shown by the statistics of Gilmour. The difference, however, is decidedly less than some authorities have claimed. Many rickety children are extremely intelligent.

Tuberculosis of the bone is another frequent cause of deformities. The parts most often attacked are the spine, hip, and knee.[1] If deformity is to be prevented, it is essential that treatment be begun at the earliest possible moment. It is stated by the best authorities that in 95 per cent of the cases of tuberculosis of the bone, deformity has set in before a diagnosis has been made.

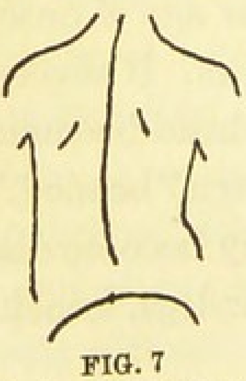


FIG. 7
Tracing illustrating a "C" curve resulting from uneven extremities. (After Mackenzie.)

Uneven length of the extremities, whether congenital or caused by disease or accident, nearly always results in greater or less spinal curvature, with deformity of the hip and shoulder.

[1] See p. 136.

Postural causes, though not nearly as influential as opinion formerly held, are nevertheless important. Standing on one leg, if habitual, has something of the same effect as uneven extremities.

Eye and ear defects often result in bad posture, and therefore favor the development of spinal curvatures. Myopia tends to cause round shoulders because of the effort to get the eyes near the book. Astigmatism causes functional lateral curvature from the tilting of the head to bring the vertical strokes of the print in the diameter of clearest vision. Deafness in one ear may cause torsion of the upper part of the spine from the effort to listen with the good ear.

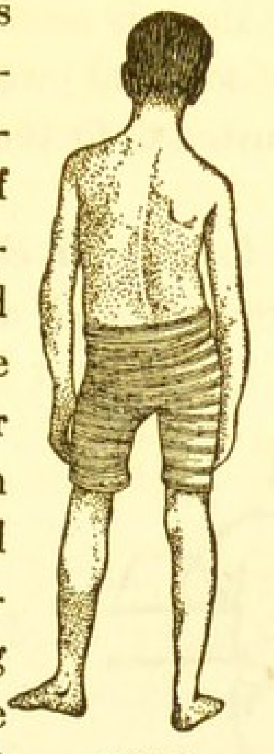


FIG. 8
One-sided position from standing on one foot — "hipping out." (Mosher.)

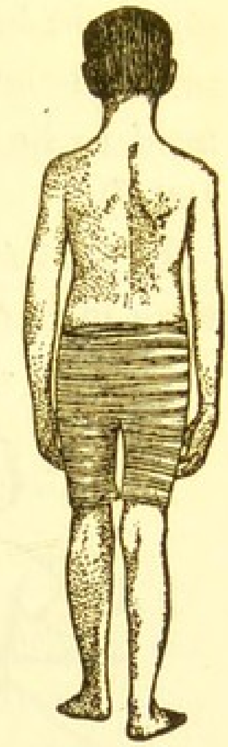


FIG. 9
The correct position for recitation or prolonged standing — one foot in advance of the other. (Mosher.)

Desks which are too high, too low, too flat, or too far from the seat are sure to result in faulty postures. The desk should be adjustable for height, for slant, and for sliding backward to afford complete rest for the arms in writing.

Because of the extreme differences in the height of children in the same grade, it is essential that the seats and also the back-rests be adjustable. Differences of four or five years in age and of fifteen inches in height are commonly found among the children of any class. Stecher's measurements of 5000 school children show that length of legs bears no constant relation to length of trunk; hence there is no constant relation between proper height of seat and proper height of desk. Both need to be adjusted to fit the individual child (4, pp. 180 *ff*).

In 1911 some forty-seven cities in the United States were in part provided with adjustable desks. Few if

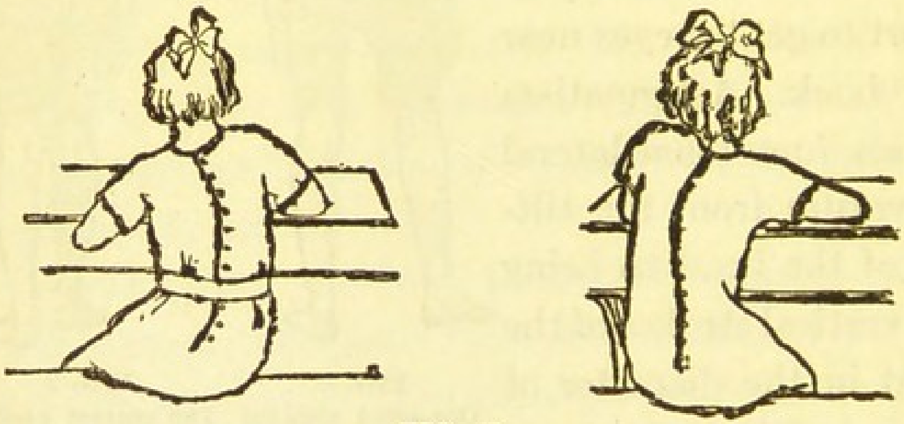


FIG. 10
Desk too high. (After Cornell.)

any cities have a full supply of them, and too often school officials neglect to make the necessary semi-annual adjustments. Experience shows that most of the pupils can be approximately fitted if ten per cent of the desks and seats in each room are adjustable, provided the remainder are divided among three sizes appropriate to the grade in question.

The handwriting should be vertical, or nearly vertical, in order to insure good posture. Measurements have shown that the average distance of the child's eyes from the paper is decidedly less in slant writing than in vertical. At the same time, vertical writing is, in itself, not a sufficient guaranty of correct posture. In all school activities constant supervision of posture by the teacher is necessary. The relation of writing posture to spinal curvatures — functional curvatures, at least — is indicated by the following facts presented by Scholder : —

TABLE 11

Positions assumed by the children in writing		Nature of the spinal curvatures found	
Spine convex to the left...	80%	Left convex scoliosis....	70.3%
Spine convex to the right..	16	Right convex scoliosis..	21.1

Other postural causes include carrying books[1] or papers always on one side, improper handling of the child during infancy, the suspension of clothing from the tips of the shoulders, piano practice, etc. That improper postures, when habitual, are an important factor in the production of spinal curvature is well evidenced by the ease with which deformities are produced artificially. Savage tribes shape the heads of their children at will by means of moderately tight bandages. The foot of the Chinese woman is another illustration. Any type of spinal curvature can be experimentally produced in dogs and rabbits by similar methods.

It is evident, therefore, that if children of abnormally plastic bones are to be prevented from developing spinal curvature, strict attention to posture will be

[1] Books should be left at school. Home study is unnecessary in the grades below the high school.

necessary. This, however, is not sufficient. The seat, the desk, and the method of writing may be ever so ideal, but if the child is kept too long at his lessons, or if the muscles of trunk and limbs are weakened by too little activity or by malnutrition, a correct posture cannot possibly be maintained. It is a dangerous delusion to suppose that vertical penmanship and adjustable desks are an efficient substitute for frequent recesses, physical activity, and adequate nutrition. The child's body demands change. It will not remain, indefinitely, even in the most "comfortable" position. The desk is really less important than the program of study and play. Mental, as well as physical, fatigue induces flabbiness of muscle and the slump of posture.[1]

If spinal curvatures are to be cured or arrested, early diagnosis is essential. By the methods of examination ordinarily used by school physicians in this country the milder cases are usually overlooked. The German practice of stripping the child to the waist is much better. In case of noticeable departure from body symmetry, exact tracings should be made to determine the exact nature and extent of the curvature.

The treatment of spinal curvatures

Spinal curvatures can nearly always be improved by proper treatment, and postural cases (cases in which the bone itself has not become deformed) can be cured altogether. Figure 11 shows the improvement possible in very severe cases.

[1] See reference to Kemsies on school desks.

Orthopedic exercises may and should be given in the public schools for the benefit of children with spinal deformities. Special classes are needed for this purpose. The work should be done by a specialist in physical

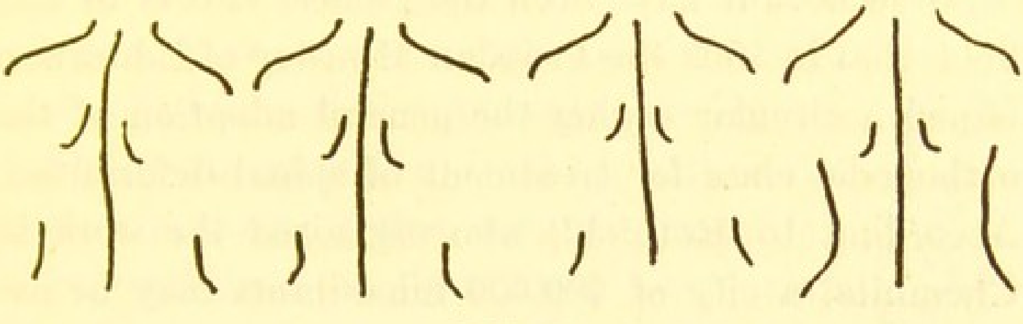


FIG. 11
Four tracings illustrating the progress of an "S" curve under treatment for three years. (From Mackenzie's "Exercise in Education and Medicine.") — W. B. Saunders Co.

training, and, wherever possible, should be under the general direction of an orthopedic surgeon.

Following the example of Düsseldorf, Charlottenburg, and Chemnitz, many cities in Germany have recently instituted "orthopedic classes" of this type. In the first class at Düsseldorf 35 per cent were cured, 53 per cent were improved, and only 11 per cent failed to respond to treatment. The corresponding figures for the second class were 51, 34.8, and 1.4 per cent. At Chemnitz there was improvement in every case, accompanied by a growth increase of from one to two centimeters in excess of that which occurred in other children of the same age.

Classes for this purpose should be small, preferably not over twenty pupils, and should meet in the afternoon for about one hour daily. To secure the maximum results from the special class it is always necessary to enlist the coöperation of parents and teachers; the former, in order to insure that the child have sufficient food, sleep, air, and rest; the latter, in order to guard against unsuitable posture during school work.

So successful have been the pioneer efforts in this field, that in 1908 the Prussian Ministry of Education issued a circular urging the general adoption of the orthopedic class for treatment of spinal deformities. According to Rothfeld, who organized the work in Chemnitz, a city of 280,000 inhabitants may be expected to have 1500 school children who should attend such classes. If this is correct, the total number in the United States must approximate 360,000.

Pigeon-breast

In pigeon-breast the chest looks as if it had been pressed together from opposite sides. This results in a decreased diameter of the chest from side to side, and an increased diameter from front to back. The chest capacity, however, is subnormal. The breast-bone projects; hence the names "pigeon-chest," "chicken-breast," "keel-chest," etc.

Pigeon-breast is observed only in children in whom there is present some unusual softness of the bones, most often due to rickets. It not infrequently follows whooping-cough in rickety children. The deformity has little or no tendency to become worse during the period of growth, and the condition is rarely of serious importance so far as the health is concerned. In many of the milder forms it disappears without any treatment. In what seem to be serious cases the advice of a surgeon should always be had.

Flat-foot

The name "flat-foot" is given to a foot that has given way under the weight of the body, and rolled inward, the muscles of the leg not being strong enough to hold the foot in its proper position. Other common names for this condition are "pronated foot" and "broken arch." The foot does not really flatten out; the arch is not really broken. The muscles of the legs have been strained by trying to balance the body's weight (which is carried to the foot by the shin bone) upon the insecure foundation furnished by the base of the ordinary shoe. The strain being too great, the muscles have weakened and the foot has rolled inward under the weight of the body.

FIG. 12
Flat-foot (Fowler). (From Mackenzie's "Exercise in Education and Medicine.")—W. B. Saunders Co.

By preventing the inward rolling of the foot, we overcome the defect. This can be done by fitting a shoe that has a proper base, a base that is as wide as the foot and that receives all the weight of the body. We do not have to support the arch, for the arch is not in danger of breaking down; but we do need to provide a proper base. The metal device known as an "arch prop," or "instep supporter," is usually unnecessary, and used without the advice of an orthopedic surgeon it may do injury.

It is the shoe that is at fault, and it is the shoe that must be corrected. The fault lies in the lack of sufficient base for the shoe. The arch prop does not correct this. When a shoemaker sells arch props to a customer, it is a confession of weakness. It is as if a builder sold a house, and after the deal was closed tried to induce the buyer to purchase some props or jackscrews to hold the house up.

The shoe worn by a flat-footed person has a characteristic appearance: the upper is bulged inward over the heel and instep; the front inner corner of the heel is worn off; there are wrinkles in the vamp just behind the ball; the sole shows the greatest wear along its inner half; the shank is pressed down until its forward end touches the ground at each step, and the stitches often give away at this point, allowing the sole to tear away from the insole. The gait of a flat-footed person is also characteristic. He walks with a stiff ankle and with the toes turned out. This is very commonly observed in girls between the ages of 16 to 24.

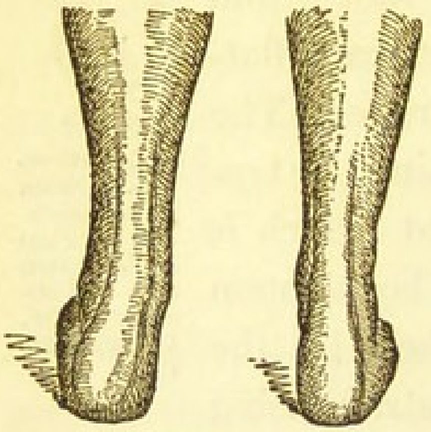


FIG. 13
Showing one of the first signs of flat-foot,—the outward deflection of the lower end of the tendo Achillis when weight is put on the foot (E. H. Ochsner). (From Mackenzie's "Exercise in Education and Medicine.")—W. B. Saunders.

Every case of flat-foot is attended with more or less swelling of the foot and leg. Because the ankle is held stiff, the muscles that move it are not brought into action, consequently they do not assist in the return of the blood to the larger veins. The blood then dilates the veins of the extremities and gives rise to swelling in the hollow of the foot, around the ankle, and in the leg. With the swelling there is soreness and a bruised feeling. The distress is not confined to the foot, but may extend to the leg, the thigh, or even the back. Most of the so-called rheumatism of the feet and limbs is really the swelling, stiffness, and pain caused by flat-foot.

FIG. 14
Imprint of (1) arched foot and (2) flat foot. The absence of impression on the inner border of the normal footprint at "A" is due to the elevation of the foot by the longitudinal arch. The other arch lies across the foot in front of this. (After Schmidt.)

If one foot is worse than the other, there will be an unevenness of the two sides of the body. The hip on the weaker side will be lower than the other, the spine will be twisted, and the shoulder on the weaker side will be higher than its fellow. The level of the body can be restored by fitting the feet to shoes that will prevent rolling inward. While many cases of flat-foot can be completely corrected by properly fitting shoes, many severe cases require treatment on the part of an orthopedic surgeon.

Flat-foot in children can usually be recognized by the heavy gait, the toes pointing outward to a marked degree, and the soles of the shoes wearing out along their inner borders. Such children tire easily, complain of pain in their legs, feet, or back, and ask to be carried after they have walked any considerable distance. The following points are important in the prevention of flat-foot in children: —

(1) The child must not begin to walk until he does so of his own accord.

(2) No kind of walking apparatus must be used; all of them are alike objectionable.

(3) The shoes must be broad and must conform to the shape of the foot. Sandals are best for young children.

(4) Neither the toe muscles nor any other muscles of the feet may be constricted without weakening them and risking the production of flat-foot.

School physicians, teachers, and school nurses ought to give careful attention to this matter of flat-foot in children. Too commonly it is allowed to pass unnoticed, with the result that as the child grows older the symptoms become progressively worse. As demonstrated by Mackenzie (13), flat-foot can be cured or greatly improved by massage, bandaging, stretching, and appropriate exercises for strengthening the muscles.

Brunner (quoted by Burgerstein) found over 10 per cent of school children with flat-foot. Mackenzie's figures showed 217 out of 1000 male college students so affected, while Dr. Canavan discovered it in 12 per cent of 2333 female students of Wellesley College. It is present in a large majority of scoliotic children (76 per cent of Roth's 1000 cases). About 3.4 per cent of the applicants for military service in the United States are rejected for this cause.[1]

[1] The author is indebted to Dr. E. B. Hoag for the above treatment of flat-foot.

The education of crippled children

Too often the crippled child has been left to grow up in ignorance. Severe deformity is still sometimes regarded as a legitimate excuse for illiteracy. What town, village, or rural community but harbors some poor unfortunate, unable from deformity to attend school, and therefore left to his own devices for education — an object of curiosity and source of amusement to those about him? Little wonder that under such an environment the moral and social instincts sometimes suffer along with intelligence, and that the personality of the cripple becomes warped. It is our neglect that is responsible for the phrase "the psychology of the cripple."

Society is at last awakening to its educational responsibility to crippled children, and public schools for them are spreading with great rapidity in Germany, England, and America. England, under the leadership of Mrs. Humphry Ward, has outstripped all other countries in this work. The first public school for cripples in London was established by the Board of Education in 1899. Since then 23 "invalid centers" have been established with an enrollment of 1880 pupils. Instruction is provided by the city, while the expense of meals is met by the "Crippled Children's Dinner Society." Many other cities of England have followed the example set by London.

One of the most famous of the European schools of this type is the Danish school for Cripples at Copenhagen. The school is supported by state grants, and combines a residential school, a hospital department, a day school, and an "out-patient" department. Emphasis is placed on vocational training. The trades taught include woodworking, brush-making, bookbinding, needlework, boot-mending, saddlery, leatherwork, etc.

The first public school for cripples in the United States was opened in New York as late as 1906. Since then 23 special classes have been formed as a regular part of the day-school system of that city. In all, about 450 pupils are enrolled. Twenty pupils are allotted per teacher, and the school day is four hours in length. Children who are able to do so come to school in streetcars; others are transported in various ways. The expenses of transportation, nurse attendance, etc., are met by the "Guild for Crippled Children."

In 1911 Chicago had two schools for crippled children with an attendance of 195. Massachusetts is the only State which supports an institution for the care and education of crippled children. This was established in 1907.

Though the beginning of this interesting movement is rich with promise, much remains to be done. It is estimated that in Germany there are 100,000 crippled children eligible for this type of school. Of these, 50,000 are in need of permanent homes. But in all Germany not quite 4000 cripples are provided for in the public schools. Of the 150,000 or more crippled children in the United States, not 1000 are enjoying the public-school advantages to which all are entitled.

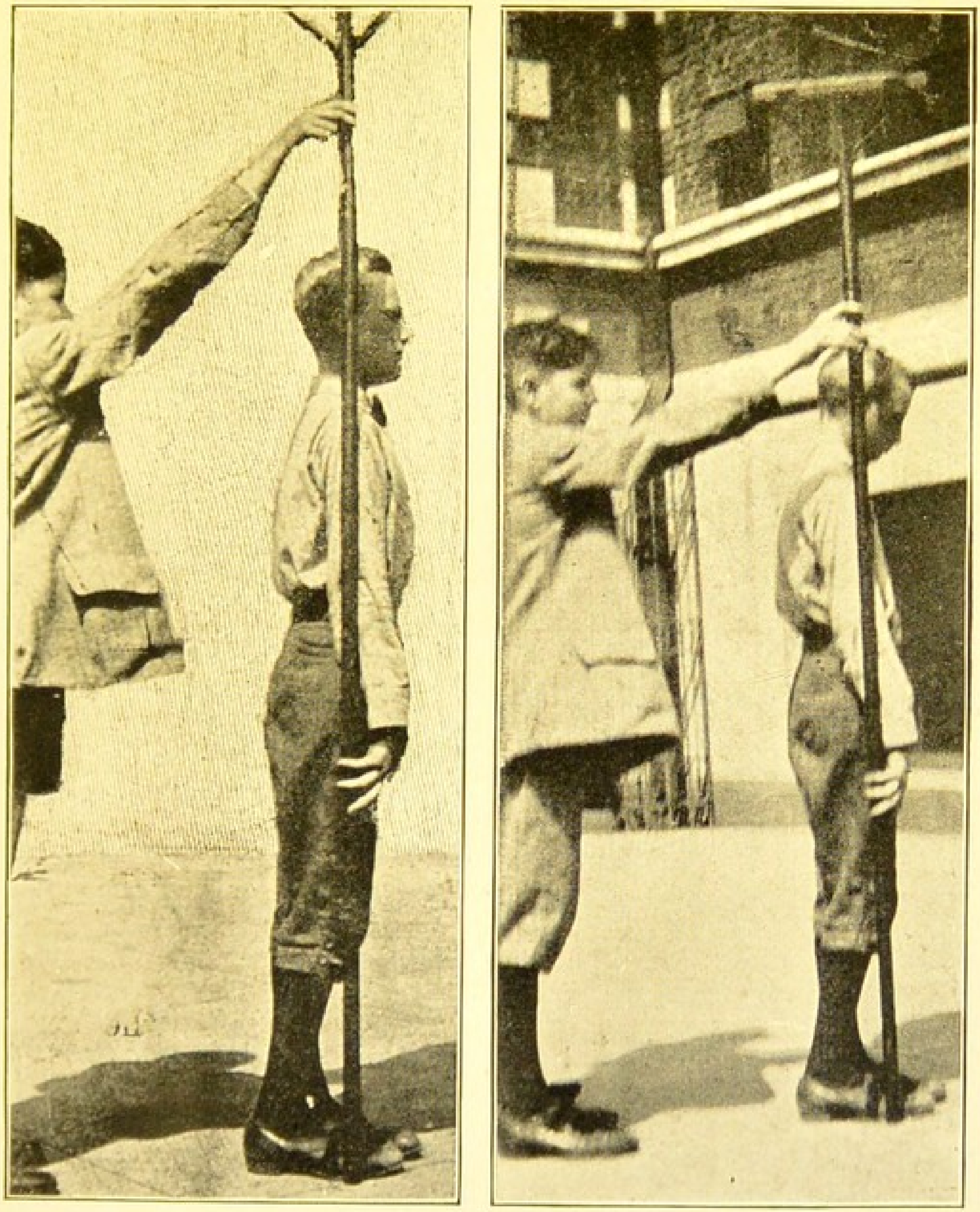
Few lines of educational endeavor are more profitable than special schools for cripples. Nearly all cripples may be made self-supporting and rendered capable of leading happy and useful lives. The child is not only taught a suitable trade, but his whole life is broadened and enriched. Intellectual interests and normal contact with other children save him from the emptiness and pettiness of the ordinary cripple's life, and the saving grace of work transforms him.

In the education of cripples a word of warning would not be out of place. Hand training should not too much replace mind training. The physically handicapped may, by perseverance, be taught miracles of muscular skill; but economy lies in a maximum culture of the crippled child's best faculties. These, very often, are mental. The greater the weakness of the body, the more dependent is the child upon the exercise of his mental powers.

Attention, finally, should be called to the need for public residential schools for cripples, such, for example, as that supported by the city of Manchester, England. This school is primarily for the benefit of crippled children for whom prolonged surgical and hospital treatment is necessary. The patients, who number about sixty, are chiefly sufferers from rickets, infantile paralysis, or tuberculosis of the bone.

In many cases of deformity, particularly that resulting from infantile paralysis, regular treatment may have to be continued for years. Generally it is impossible to insure that the treatment will be rightly carried out in the home. Nor is it just to the child that his mental powers should be allowed to atrophy while his body is being put in condition. The Manchester school combines all the advantages of the children's hospital with those of a regular school. The hours of instruction are from 9.30 to 12 and from 1.30 to 3.30. Most of the time is spent in the open air. The instruction is largely vocational. The average length of stay is two years, and the cost per child is less than $200 per year. Since the school was established in 1905, 98 children have been sent out, most of them so improved as to be able to enter regular classes or to take a secure place in the industrial world. The official report states that rickety, distorted cripples, unable to walk, are discharged after two or three years with sound, straight limbs requiring no artificial support and showing no tendency to relapse. There are yet no residential schools of this type supported by any municipality in this country, although it is said there are 18,000 children in the city of New York alone undergoing prolonged treatment in children's hospitals.

The obligations of society to the crippled child are perfectly clear, and the educational activities we have just sketched are of the greatest promise. The movement should continue until the educational rights of crippled children are everywhere recognized and given first claim to attention.



A VERY SERVICEABLE TEST FOR POSTURE

From Bancroft's "Posture of School Children," by permission of The Macmillan Company, New York.

TABLE 12

General survey of leading deformities

Kyphosis (outward curvature)	Lordosis (inward curvature)	Scoliosis (lateral curvature)	Flat-foot
Signs	*Signs*	*Signs*	*Signs*
Round back Round shoulders Angular projection in the dorso-lumbar region Wing shoulder blades Flat chest	Back curving inward Protruding abdomen. (Often present with kyphosis)	Inequality in height of shoulders One hip higher than the other Wrinkling of clothes on one side of the back	Ankle turned inward Shoe heel worn out on inner side Stiff, inelastic gait Toes turn outward in walking Barefoot-track test
Causes	*Causes*	*Causes*	*Causes*
Muscular weakness Rapid growth Rickets Tuberculosis of spine Forward posture in school, etc.	Hip-joint disease Dislocation of hip Rickets	Weak muscles Malnutrition Rickets Tuberculosis of spine or hip Some form of paralysis Faulty postures	Muscular weakness Improperly fitting shoes Jumping

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CHAPTER VIII

MALNUTRITION IN SCHOOL CHILDREN

The importance of nutrition

"MALNUTRITION" is a much broader term than "starvation." The latter is ordinarily used to designate the condition of extreme insufficiency of food. But malnutrition is probably half as prevalent among the well-to-do as among the poor. A child may be ill-nourished either because of insufficiency of food, because of inherent weakness of the power of food assimilation, because of disturbances of the digestive processes, or because the food has been improperly chosen or unsuitably prepared. Accordingly, the educational and other sociological aspects of our problem are just as important as the economic.

Nutrition is fundamental for all lines of child development. The stability of the bodily structure is dependent upon the materials that make it up. Malnutrition during the period of growth leaves permanent flaws in the constitution. It is responsible for more degeneracy than is alcohol. Alcoholism is often nothing but a symptom of disturbed nutrition. The greatest problem throughout childhood is that of feeding.

The influence of food on growth in height and weight has already been set forth, and has been shown to rank in importance with the influence of race. In the children of the poor, puberty is reached late and the pubertal growth acceleration is slurred over. Resistance to infection is markedly decreased. Ill-nourished children "take" everything. Malnutrition is almost the invariable forerunner of tuberculosis, chorea, and many other diseases. It also renders recovery less certain and increases the liability to relapse.

The effects of severe malnutrition are well illustrated by the hookworm disease. The hookworm victim of 26 years may present a state of sexual and skeletal development normal to that of the 14-year-old child. Children of 14 years present the general appearance of 10-year-olds. Growth and development are interfered with and to an extent proportional to the number of the parasites. The disease is extremely prevalent in some areas of the Southern States, sometimes from 50 to 60 per cent of the children being affected.

The effect of malnutrition on mental development is probably very great, though difficult to measure accurately. Malnutrition is from two to three times as common among children who are badly retarded mentally as among those making average progress. Plans for the feeding of school children have in this country usually originated among the teachers of special classes, and increased mental alertness is always a marked sequel of school feeding. Bean has reported a case of permanent peculiarity of mental development resulting apparently from severe and prolonged malnutrition during the pre-school period (3). Dr. Warner found from his examinations of 100,000 London school children that 28 per cent of the dull pupils were ill-nourished, and conversely that almost the same percentage of the ill-nourished were dull. Macmillan and Bodine found that of 2100 retarded children, 54.6 per cent were suffering from malnutrition. It is probable, however, that the mental effects are less marked than the physical. The tissues do not suffer equally, but roughly in proportion to their importance. Starvation may reduce the weight of the muscles nearly 50 per cent while effecting a loss of only 1.1 per cent upon the central nervous system (31). The survival value of such an arrangement is obvious.

Are many children ill-nourished?

In order to estimate the importance of malnutrition as a problem in child hygiene it is necessary to gain an idea of its prevalence. But difficulty arises here because of the absence of any definite and universally accepted criterion. Perfect nutrition gradually shades off into slightly unsatisfactory nutrition, and the latter into extreme malnutrition. Some medical examiners report only the latter; others report all cases which present symptoms of subnormality. If this is borne in mind, such disagreement as may be found in the statistics about to be presented will not be misleading.

Perhaps the most thorough investigation yet made in this country is that of Macmillan and Bodine (9). This investigation included an examination of 10,000 children in one of the poorer districts of Chicago. The proportion suffering from malnutrition varied from nearly 16 per cent among kindergarten children to about 6 per cent above the fourth grade. These figures avowedly include only the extreme cases. Harrington's report on the 90,000 school children of Boston places the number of anæmic and ill-nourished at approximately 5000, or nearly 6 per cent. Of 2000 children examined in certain New York schools, in 1909, more than 13 per cent were reported ill-nourished. Robert Hunter and John Spargo (40) estimate that there are probably 2,000,000 school children in the United States suffering from malnutrition.

The report of the Royal Commission estimated that 9 per cent of the school children of Aberdeen, Scotland, are under-nourished, and 29.8 per cent of those in Edinburgh. Eicholz estimated the ill-nourished school children of London at 16 per cent, and Dr. Macnamara at 10 to 15 per cent.

Dr. Crowley, of Bradford, England, classified 817 school children according to nutrition into three classes. The following table represents his results. Group A represents pupils from the better districts of the city; Group B those from the poorest.

TABLE 13

Nutrition	Infant School		Upper School	
	Group A	Group B	Group A	Group B
Good	55%	31%	68%	24%
Below normal	36	35	25	43
Poor or very poor	29	34	7	33

The following table from Dr. Arkle shows the conditions of nutrition found among 1026 boys and 921 girls in the secondary schools of Liverpool. The columns A, B, and C correspond to schools attended by the children of the best classes, the middle classes, and the poorest classes respectively.

TABLE 14

Nutrition	Boys			Girls		
	A	B	C	A	B	C
Good.......	80. %	28.5%	10.5%	91.6%	65.7%	16.9%
Fair........	17.8	60.1	35.3	8.1	33.9	52.5
Poor........	1.3	9.7	48.6	0.0	.7	28.6
Very bad....	--	.7	2.4	0.0	.0	1.8

In Germany, Wimmenauer reports (1912) an exceptionally careful study of the nutrition of 1942 school children in Mannheim. His results are summarized as follows: —

TABLE 15

Nutrition	Boys	Girls
Good.................	18.8 per cent	31.2 per cent
Medium..............	62.6	55.
Bad..................	18.6	13.8

One of the most thorough studies yet made is that of Gaspar (16) of 8037 children, of Stuttgart, 6 to 14 years of age. His procedure was to arrange the pupils of a room in a row so as to show a progressive degree of paleness. Then he placed by themselves all those whose color was unsatisfactory, and rearranged this group according to thinness. The following classes are then distinguished and in the proportions named: —

TABLE 16

1. Excellent in all respects	24.6 per cent
2. Average	32.7
3. Average nutrition with pallor	17.3
4. Deficient nutrition without pallor	13.
5. Deficient nutrition with pallor	12.3

If groups 4 and 5 are thrown together and group 3 regarded as satisfactory, we have a total of 25.3 per cent ill-nourished.

Fewer studies have been made in rural schools. Such evidence as is available indicates that the proportion of ill-nourished is somewhat less than in the large cities, but that it is very great. This is further indicated by the fact that tuberculous school children are only a little less numerous in country than in city schools. Of course there are exceptional schools, both rural and urban, where few ill-nourished children are to be found, but the teacher of forty children may ordinarily expect to have anywhere from two or three to eight or ten who are below par in nutrition. It would be well for her to try to identify them and to correlate her findings with their school progress, deportment, nervous control, etc.

The above statistics, which are all based on actual medical examinations, thus show that from 6 to 30 per cent of the school children suffer from malnutrition. The average would seem to be between 10 and 15 per cent, at least for cities, throughout western Europe and

America. The number is largest in the earlier years and decreases gradually in the upper grades.

Inadequate feeding as a cause of malnutrition

Investigations usually show that from 10 to 15 per cent of those living in the poorer districts of our large cities are inadequately fed. Leckstrecker found that of 10,707 industrial school children of New York City, 439 had no breakfast, 998 had only coffee and bread, and only 17 per cent a satisfactory breakfast; 998 were anæmic. Harrington found that of the 5043 ill-nourished children in Boston, 33 per cent received an "unsatisfactory" breakfast. Seventy per cent of Boston's poorly fed came from homes classed as well-to-do. Of 12,800 children in 16 New York schools who were questioned privately by the principals, 7.7 per cent had no breakfast, and 15.3 per cent more only bread with coffee, tea, beer, etc. A similar investigation in Buffalo returned 4.46 per cent as breakfastless and 9 per cent more as having had entirely too little. Macmillan states that at least 5000 children in Chicago are habitually hungry.

Bernhard [1] found that of 8451 school children of Berlin, .5 per cent had had no breakfast and 6.8 per cent almost none. In Munich, a few years ago, 1557 breakfastless school children were found. Christiania, Norway, had over 3000 ill-nourished school children in 1901. Of these, 52 per cent had no breakfast, the remainder only coffee and bread. In Pavia, Italy,

[1] See Kelynack's *Medical Inspection of Schools*, p. 374.

January 17, 1900, of 2500 children in four schools, 10 per cent had come to school without breakfast and 50 per cent with an inadequate one. In Padua, the same year, over 5 per cent had no breakfast and nearly 50 per cent one that was unsatisfactory.

Data secured by Dr. E. B. Hoag from 3000 school children in the smaller cities and towns of Minnesota showed that 65 per cent had breakfast with no proteid, 85 per cent with no fruit, and 60 per cent without either a fruit or a proteid food.

If the breakfastless child invariably received a satisfactory dinner and supper, the situation would not be so serious. But investigations show that this is not the case. Among families which are either poor, ignorant, or neglectful, the noon meal is likely to be even worse than the breakfast. In one group of New York's badly nourished children, 68 per cent returned at noon to homes where no regular noon meal was prepared. In two schools where 13.3 per cent of the children were ill-nourished, 5 per cent of all the mothers worked away from home. In such cases the pennies which are given to the children for buying lunches are usually expended for the worst imaginable food,—cookies, candy, cream puffs, cornucopias, doughnuts, third-grade bananas, pickles, etc. The more extreme and chronic the insufficiency of nutrition, the more perverted the appetite is likely to be. As Spargo has remarked, the craving of the ill-nourished child for pickles and other unwholesome articles of food is analogous to that of the alcoholic fiend for his favorite beverage. Much of the food thus purchased by the child comes from street venders and other questionable sources, and is likely to be unclean as well as unwholesome.

We must regard inadequate feeding, therefore, as one of the important causes of malnutrition. This is due sometimes to poverty, but more often to ignorance and neglect. The statistics just quoted show this convincingly, though it is of course impossible to separate the influence of poverty, ignorance, neglect, bad housing, deprivation from play, sleep, etc. Regularity of meals and care in the selection and preparation of the child's food cannot be too strongly emphasized, and in such matters the parents in comfortable houses are often at fault. Children pay the penalty when mothers have not been rightly educated. The malnutrition problem is therefore about one third economic and two thirds educational. Teacher and school doctor should not hesitate to inform well-to-do mothers when their children are found undernourished, even at the risk of giving offense.

Other causes of malnutrition

In the case of no other common defect is the degree of parental care so great an influence. Investigators find, for example, that malnutrition is far less common among Jewish than among Gentile children, even when the latter are at an economic advantage. Dr. Hall's figures show Jewish children in London to be $6\frac{1}{4}$ pounds heavier and $2\frac{1}{2}$ inches taller at the age of ten than other children in the same schools (11, p. 490). The mortality rate for Jewish children in the first year is decidedly lower in every country than that for children of other peoples. The difference is not thought to be due to racial heredity, but to the more general care given to infants in the Jewish home.

Parental neglect and ignorance are often responsible for underfeeding, for pampering the child in his food habits, and for the use of stimulants such as tea, coffee, and alcoholic drinks. The same cause is responsible for insufficiency of sleep, over-excitement, and many other enervating influences which affect the child's ability to digest and assimilate its food. The child thrives not on what it eats, but on what it can digest and assimilate.

Insufficient clothing aggravates malnutrition by robbing the body of its heat. The child who is scantily fed and scantily clothed is compelled to burn his candle at both ends. For many a pinchbeck youngster, boots and a warm dinner are equally necessary.

The overwrought, nervous child is nearly always ill-nourished, and this in turn aggravates still further the nervous instability. Carious, aching, or irregular teeth and diseased gums are at the bottom of many cases of malnutrition. Adenoids and enlarged tonsils induce a condition of general toxæmia which profoundly affects nutrition. Many cases are traceable almost entirely to eye strain, or other reflex nervous disturbances, such as those produced by parasites, etc. Worry and unhappiness have a similar effect. Rollicking fun and happiness are essential alike for correct physical and for healthy mental growth.

External causes seldom act alone. There are children of robust constitution whose growth momentum seems to defy every kind of unfavorable environment. There are others whose growth suffers for every trifling cause. These are the children whose powers of digestion and assimilation are feeble by native endowment. "Delicate" best describes them. They are often bright, nervous, and sensitive to every influence. The combined efforts of education, medicine, and home training are necessary in order to usher such children into an efficient manhood or womanhood. With them the strenuous life of the school may be but an added burden. Let the school beware that it cast not its influence with the afflictions of evil heredity and stunting environment.

The assimilation of food depends not only on the food itself and the soundness of the digestive apparatus, but fully as much upon the influences exerted on metabolism by bodily activity. The tissues can starve for oxygen in the out-of-doors if the bodily functions are not stimulated by exercise. In like manner, the child who hugs his books for six or more hours per day may suffer malnutrition in the midst of abundance. There is no way for the school to atone for the evil it does when for a dozen years it assiduously cultivates pernicious habits of sedentary living.

Identifying the ill-nourished

The worst cases of malnutrition can be identified easily enough by any one whose eye has been trained to detect unhealthy skin color, thinness of the body, undersize, and the symptoms of lassitude. But in the case of many children a sure diagnosis is not gained by casual inspection. In a field where even the experienced school doctor sometimes falls into error, the teacher cannot hope to avoid all mistakes. It is believed, however, that nothing but good can result from a habit of attention to the symptoms most commonly involved.

In malnutrition the face is not usually thin and pinched, but often plump in appearance, and for this reason many cases are overlooked. In such cases the fat lacks firmness and is not healthy. Often there is a fullness under the eyes. The color is usually, but not invariably, pale.[1] The skin is likely to be harsh and inelastic, the hair deficient in luster, and the eyes dull or "nervous," with pale-blue rings beneath. The breath may be foul, with other symptoms of indigestion. Motor symptoms are common, especially twitchings of the eyelid and tongue, unsteadiness of body balance as shown by Warner's simple tests; and in extreme cases movements approaching the choreiform may be marked. Stuttering may develop. The child usually plays less actively than the average, fatigues easily, and sleeps badly. Nightmares, groundless fears, and obsessions are common. The child may be either apathetic and listless or else abnormally high-strung and irritable. Children of the latter type are easily worried by school work and develop finical habits. The

[1] The examiner must remember, too, that the color of the skin is influenced by the temperature of the room, previous exercise, racial heredity, etc.

appetite is nearly always diminished and is likely to become freaky. Queer food preferences and violent aversions are formed. The best foods are likely to be just the ones most disliked. If the parents are unwisely indulgent, the child becomes spoiled.

Growth may be markedly affected. Height, weight, and chest girth are below par in a large majority of cases. Measurement of weight alone will disclose many cases of malnutrition, as Wimmenauer has shown, but because of racial and family differences, this test is too unreliable to use as the sole criterion in the individual case. Nevertheless, if a large number of children belonging to a fairly homogeneous race are weighed and found to average considerably below the weight norms for that race, it may be inferred that the group contains an undue proportion of undernourished children; also that a majority of those falling farthest below the norm for their respective ages are undernourished. In the experiment already referred to, Wimmenauer classified 1942 school children according to external symptoms of nutrition and then compared the well-nourished and the ill-nourished in height and weight. The following table shows the average excess in height and weight of the well-nourished group over the poorly-nourished group for the ages 6 and 9: —

TABLE 17

Age	Boys		Girls	
	Height	Weight	Height	Weight
6 to 7	5.0 cm.	3. kg.	4.4 cm.	2.8 kg.
9 to 10	6.2 cm.	5.5 kg.	8.0 cm.	6.3 kg.

Other common growth symptoms, in case the malnutrition is long-standing, are carious teeth, delayed dentition, scoliosis, and rickets. Scoliosis is favored both by the less active life and by the muscular weakness. Rickets is indicated by knock-knees, bow-legs, pigeon-chest, beaded ribs, enlarged joints, and sometimes retarded mental development. Rickets is not strictly a "bone disease," but a special form of malnutrition which has many other results besides that of weakening the resistance of the bones.[1]

It is easy enough to pick out the half-starved horse or pig from his well-fed companions, but in the case of the child, clothes and tidiness deceive. If the skin over the ribs is smooth and well-filled out above and below the nipples, nutrition is probably not defective. There should be no marked depressions between the ribs. According to Wimmenauer (42), if these appear beneath the nipples only, the nutrition may be considered "medium," but if there are deep furrows both above and below the nipples, the nutrition is "bad." Wimmenauer also suggests that measuring by means of caliper compasses the thickness of a fold of the skin held between the thumb and finger gives a better idea of the quality of the adipose tissue than can be gained by mere inspection.

The Oppenheimer formula for the determination of nutrition has been extensively employed with school children by Schuyten. According to this, the coefficient of nutrition equals

[1] See p. 79.

$$\frac{\text{girth of arms} \times 100}{\text{chest girth}}.$$[1]

The condition of the blood is a valuable index of nutrition. The red corpuscles may be deficient to the extent of 1,000,000 or more for each cubic millimeter of blood, while the hæmoglobin content may run as low as 60 per cent. School children should ordinarily have a corpuscle count of about 4,500,000 per cubic millimeter, and a hæmoglobin content of about 85 to 90 per cent. Pre-tuberculous children entering open-air schools have usually a hæmoglobin content of 65 to 75 per cent. This is the reason for the observed pallor and helps to explain their high fatiguability and low power of resistance to disease.

So many disorders of childhood are ushered in by anæmia that it would be well if every child could have two or three blood tests during his school life. Anæmia is especially common among girls in the earlier years of adolescence. If blood counts were common for the high-school girls, teachers might consent to ease somewhat the burden of work for a year or two in the case of many pupils. For the anæmic school child, boy or girl, there is no cure short of fundamental reform of nutrition, and this is possible only through a wisely selected diet, active play, sleep, rest, and a happy life.

Suggestions for identifying the ill-nourished school child

The teacher cannot hope in many cases to make the identification certain. The following, however, are

[1] If nutrition is normal the quotient is at least 30.

some of the common indications of malnutrition. The child who shows several of the symptoms named is likely to be ill-nourished, and should be referred to a physician for examination.

Is there pallor of skin?
Is the child extremely thin?
Are there furrows between the ribs?

$$\text{Does } \frac{\text{the arm girth (midway between elbow and shoulder)} \times 100}{\text{chest girth (average between expiration and inspiration)}} = 30?$$

Is the flesh soft and flabby?
Is there puffiness under the eyes?
Is the posture slouchy?
Does the child appear to lack physical energy?
Does the child prefer quiet games or books to boisterous play?
Is the child listless?
Is mentality slow?
Is the appetite freaky (lack of appetite, preference for highly seasoned foods, etc.)?
Are there symptoms of nervousness?
Does the child have frequent headaches?
Is physical endurance good?
Does the child take cold easily?
Is there shortness of breath?
Is sleep disturbed?
Are there indications of earlier rickets (bow-legs, knock-knees, pigeon-breast, spinal curvature, badly decayed teeth, etc.)?
Are the neck glands enlarged?

The responsibility of the school

The first duty of the school is to feed its hungry pupils. The oft-heard argument that the school has no concern with the child, except to educate him, is now an anachronism. In its vocational instruction, play supervision, moral education, health examinations, and medical clinics the school has once for all cut loose from its moorings to the "Three R's." The school is not an unchangeable entity whose functions are predetermined and limited by definition. It is fast becoming the recognized agency for every kind of child-welfare work, and the most effective leverage for raising the new generation to a higher level than our own. As Robert Hunter reminds us, the world and all that is on it will soon belong to the children now in our schools, and every means is legitimate which can help to make them more worthy to possess it.

Advocates of school feeding are therefore not disturbed by the cry of "socialism." It is no more socialistic than free education, free textbooks, free pencils, free playgrounds, and medical inspection. It is no more socialistic to heat the child's body internally with food than to heat it externally by warming the air of the schoolroom (7).

But is not school feeding a species of paternalism which will undermine parental responsibility? Some people are obsessed by this pauperization argument. Parents did not lose interest in education when the State assumed control of it. Health supervision in the schools does not make parents negligent of the physical welfare of their children. On the other hand, the more interest the State displays in its children, the more the feeling of parental responsibility is awakened.

The sad truth is that, too often, the parents of necessitous children have little parental responsibility to destroy. The home is a home in name only. The interference of the State in behalf of the children of such parents is the best guaranty that the parents of tomorrow will be different.

Even if parents *were* pauperized, school feeding would still be necessary. Our first duty is to the children, not to the parents. "No argument, moral or economic, can defeat the claims of a hungry child." "After bread, education," is the unanswerable slogan of the Fabian Society. The State which protects children from cruel beating will sooner or later protect them also from slow starvation.

But why public charity? Cannot private philanthropy cope with the evil? The answer is that it is not rightly a problem for charity at all, any more than is education itself. Children have a right to food, and when it is not otherwise forthcoming the State has the duty to supply it. If private charity were sufficient there would not be so many ill-nourished children.

Besides, the presence of such children in the school interferes with the educative process itself. Malnutrition makes children dull and retarded. We should not expect them to "make brick without straw." To feed them is both less expensive and more effective than to educate them as defectives in special classes. The school has the right to protect itself against the non-functioning home.

The duty of the school is so much the clearer for the reason that it is itself one of the causes of disturbed nutrition. It imposes upon the child a sedentary life, instills sedentary habits, confines him in an unhealthful atmosphere, and adds the burden of five or six hours of mental work which often entails nervous strain and anxiety.[1]

Finally, it should not be overlooked that the school meal may be made an educational influence of the first rank. It offers the very best means of teaching children neatness, cleanliness, and good manners. The hygiene of foods, the "balance" of meals, the danger of flies, the importance of thorough mastication, and the care of the teeth cannot be so effectively taught in any other setting. The work of preparing the meal offers the highest type of training in social coöperation. Some of the ill-nourished school children never sit down to a meal in the "home." Only a few regularly use a tooth-brush or wash the hands before meals. Their parents often have no conception of the food requirements of children.

And these parents were in the public schools a few years ago! If the State had not neglected its duty then, it would have smaller responsibility now to their neglected children.

The best argument for school feeding is its success where tried. For many years most of the cities of central and western Europe have served free meals to their necessitous school children. Denmark supplies by public taxation free lunches to one third of the pupils in the elementary school; Brussels to one fifth, and in one borough to all. One half of the German

[1] Chapter XXI.

cities serve either breakfast or luncheon. Munich began the work over a century ago, and now continues the free meals right on through the holidays. Fifty cities of Italy were serving free meals in 1910, about one half of the expense being met by taxation. Vercelli has a unique and praiseworthy system, making attendance upon the free meals compulsory for all the children. Padua has served free school breakfasts since 1901 to the number of about one half million annually at a cost of about two cents each. Tonzig (41), who has studied the Padua School dietaries, reports that for very many of the children it is imperative that half of the day's food requirement be met by the free breakfast if the children are not to starve. In Italy breakfast is usually preferred to luncheon. Free meals are common in nearly all the cities of Norway, Sweden, Switzerland, Spain, France, and England. London expends over $300,000 annually in this way, but in London, as in other English cities, every case must be passed on by charity organizations, food being supplied free only in cases of extreme necessity. The usual criterion of necessity is a family income of less than three shillings (seventy-five cents) per child per week. Real want, of course, begins well above this point.

The most advanced country in the treatment of necessitous school children is France, which supplies free meals and clothing in nearly every city. Marseilles feeds 10 per cent of her school enrollment. Nice serves free luncheons to all of its kindergarten children without distinction. Nearly all of the recently constructed school buildings in the towns and cities of France are supplied with kitchens as a matter of course. The Paris system of feeding is the finest in the world. Lunches are served in practically every school and are patronized by teachers and pupils, rich and poor. Children who can afford to pay for their meals are expected to do so, but those who bring no money are given their meal tickets without question. The method of supplying tickets is such that no child knows which ones of his fellows get their meals without payment. One third of the children of Paris receive free lunches by this system, and one thirtieth of the total school expenditures are for this purpose. In Paris, after a third of a century of experiment, the tendency is to enlarge the school dietary and to exact less and less in the way of payment.

America is behind Europe, but is making rapid progress. Boston first served free meals in 1894, and now supplies them in several schools at the low cost of two cents. New York, which began in 1909, has a School Luncheon Committee, under whose auspices substantial school meals are served in various centers at the low price of three cents, with an opportunity for "penny extras." Chicago undertook the work on a fairly large scale in 1910, and at the present time something is being done in most of our larger cities. Although the beginning is most promising, probably, the country over, not more than one ill-nourished child out of a hundred is receiving the full attention his case merits. With us the school lunch is seldom free, and ordinarily receives no public support beyond the kitchen equipment and supervision. The remaining expenses are met by the fixed charge for meals and by various charity organizations, parents' clubs, private philanthropy, etc.

School meals should, when possible, be under expert dietary supervision so that the maximum amount of food value may be secured for a given outlay. In small schools attended by older children it is often feasible to enlist the services of pupils in the preparation and serving of the meal, and in clearing the table, washing dishes, etc. This is commendable because of its educative value. Experience proves that when the cost of raw materials alone is met by the children an appetizing and nutritious meal may be served for about three cents. In Philadelphia one cent buys about one hundred calories. The foods most in evidence are sandwiches, soup, macaroni, shredded wheat, rice pudding, cereals, potatoes, hominy, fruits, milk, cocoa, etc. It is necessary in some schools to take account of racial food preferences. As regards expense, until the time comes when the school lunch takes its regular place as a part of the school program, as free as tuition, the Paris method of meeting the cost is nearest to the ideal.

Nowhere is reform more urgent than in the lunch ceremony of the rural school. Because children live in the country is no reason why they should eat with dirty hands and piggish manners. As Mrs. Ellen Richards suggests, the noon hour in these schools could very well be utilized for social training and the acquisition of good habits and refined tastes. Mrs. Richards (37) sketches an admirable plan for the rural-school lunches, including such details as the arrangement of the table at which the pupils eat the lunches they have brought from home; the use of paper napkins, paraffin paper for plates, and a kerosene heater for preparing some special dish to supplement the individual lunches. The material for the supplementary dish can be paid for by penny or two-cent contributions from the pupils. A mothers' organization or a local church can usually be found to defray such shortages as may arise from the inability of a few pupils to pay their share. By varying the supplementary dish and by permitting the older children to aid in its preparation much excellent instruction in cookery can be worked in. Why not a toothbrush drill to follow the meal?

In combating malnutrition two other important lines of influence are open to the school. Open-air schools, with their shorter study program, emphasis on play and manual work, the after-lunch sleep period, medical supervision, etc., are no less important than school feeding. The two methods of treatment should go hand in hand.

Even the mere contact of air currents with the body profoundly influences its metabolism. Experiments of Rubner (quoted in 31) prove that air currents too mild to be perceptible have this effect from passing over a small exposed surface like the forearm. The sensation threshold for air currents is about one half meter per second, while metabolic changes were detected for air currents of one third this velocity. The effect of a thoroughgoing outdoor regimen must therefore be very great.

Another method to be commended is that of undertaking systematic instruction of parents on children's food requirements. This method has been used by Poelschau in Charlottenburg with gratifying results. Leaflets were prepared setting forth in simple, untechnical language the importance of food for healthy growth, and giving suggestions on such subjects as food values, balance of foods, sample dietaries for children of different ages, the injury produced by alcohol, tea, coffee, abuse of sweets, etc. In the worst cases it is advisable for school nurses to visit the homes and give personal assistance and advice. The food leaflet is an easy means of reaching all the homes, and while the advice it contains will often fall upon stony soil, the amount of good accomplished is probably very great in comparison to the time and expense involved. It may be sent to every home once each school year, and in the case of the badly malnourished it may be supplemented by additional leaflets giving more detailed suggestions.

The problem of malnutrition is one which presents numerous aspects and varied relations, raising, as it does, fundamental questions in sociology, economics, physiology, and hygiene. The problem is not solved by an occasional dole of food in or out of the school. What is demanded is a constantly adequate diet, better housing and clothes, opportunity for play, rest, and sleep, and vigilant medical supervision of the entire life. With the possible exception of housing, the school can make an immense contribution along all these lines, and by appropriate education in household science, hygiene, and related matters can give us a new type of parent for future generations of children.

Children's dietaries

For extended treatment of this subject the reader is referred to references; as 6, 14, 20, 21, 23, and 34, at the close of this chapter. It is a subject which should be taught in one form or another from the sixth grade to the university. Only a few points of special importance will be touched upon here.

Children need much more food than adults in proportion to size. The child of 6 is less than one third of the adult weight, but requires one half as much food. Almost as much food is required for the child of 12 as for the adult engaged in moderate labor. If diet is insufficient during adolescence, irreparable harm is likely to result. Throughout childhood the danger is on the side of undereating rather than overeating. When children are given the appropriate variety of wholesome foods and are required to masticate thoroughly, the matter of quantity can be left for automatic adjustment.

In addition to repairing the daily losses, the child must grow, and it is therefore hardly to be supposed that the low calories allowance favored by Chittenden for adults would be suitable for children when proportionately reduced. It has not even been proved sufficient for adults, indefinitely and under all conditions. The results of superabundant feeding in open-air schools, etc., would seem to suggest the importance of a factor of safety in children's diet. In order to provoke the greatest amount of food assimilation by the tissues it is probably necessary to offer them a little more than they actually need. A very slight deficiency extended over three meals a day for 365 days in the year may, in the long run, make all the difference between a well-nourished and a poorly nourished child. During convalescence from illness the problem of diet becomes doubly important.

The science of nutrition involves its psychological as well as physiological and chemical factors. A theoretically perfect diet may work poorly in practice because of the mental attitude it calls forth. Food that provokes disgust or any other unpleasant feeling is badly digested. Food preferences and aversions sometimes have a physiological basis, but are sometimes the result of prejudice and bad food habits. Bell (4) has shown the infinite variety of these, and the important part played by them in determining children's diet. When the aversion is such that repeated effort on the part of the child does not eradicate it, or when nausea and vomiting are provoked, it is best to omit the article of food altogether. But those who superintend children's meals should take every opportunity to uproot such aversions and injurious preferences as are founded purely on whim and habit.

One boy known to the writer persistently refused for many years milk, butter, meat, turnips, carrots, green beans, lettuce, celery, parsnips, beets, cooked tomatoes, and cabbage. Contracting tuberculosis at the age of 21 years, he was led to consider the desirability of overcoming his food prejudices. He, therefore, set about the matter in earnest, with the result that for all but one of the foods (parsnips) the aversion was readily overcome, almost at the first trial!

Bell's investigation of the food preferences and aversions of over 1400 children, mostly 6 to 14 years of age, shows that few children escape such aversions altogether and that very many contract them in the early years. Some of the aversions seem to be characteristic of certain well-defined stages of growth. The school meal offers an excellent opportunity for the education of the food habits.

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CHAPTER IX

TUBERCULOSIS AND THE SCHOOL

The ravages of tuberculosis

THE annual loss of lives from tuberculosis in the United States amounts to about 150,000.[1] We have constantly one half million people ill with the disease. About two million others are kept more or less unhappy from living in families where the disease is present. If the death rate is not materially reduced within the next few years, five million of the present population of the United States will die of the disease. More than two million children now attending our public schools will fall victims to this plague unless something is done to save them. This is several times as many as will die from smallpox, diphtheria, and scarlet fever together.

Unlike most diseases, tuberculosis strikes down the majority of its victims in the years before middle age, when society has already met the cost of rearing and educating them and when their economic productivity is at its maximum. On an average, each death from tuberculosis cuts off twenty-four years of life, seventeen years of which would be highly productive. The average period of total or partial disability from the disease is about three years. The annual loss in wages,

[1] Probably not more than this number of soldiers were killed in battle in all the four years of our Civil War.

medical attendance, etc., amounts to more than one billion dollars. This is interest on a capitalized sum of twenty-two billions. The loss is equivalent to an average annual tax of fifty dollars for each family in the United States. The loss each year is almost twice as great as our total annual expenditure for public education and more than twice as great as the annual cost of our army and navy.

Most of this loss is ultimately preventable and probably one half of it immediately so. Let the teacher compute the educational harvest that could be reaped by the next generation if only one half the yearly cost of tuberculosis could be devoted to increasing the number of teachers, to the improvement of salaries, to the establishment of vocational high schools, continuation schools, playgrounds, health supervision, etc.

By what means and through what agencies may this saving be effected? One thing is clear: tuberculosis is at present largely a social and educational problem. Barring the possibility of some medical discovery which would eradicate the disease, the medical profession, unaided, will hardly more than enable us to maintain the slight advantages that have already been gained. Relatively few cases, indeed, come under the notice of a physician until the most favorable time for effecting a cure has passed by. The battle cannot be won for the present generation, but by concentrating our efforts upon children it may be won for the next. All the constructive forces of society should be organized to this end.

Tuberculosis in childhood

The mortality from tuberculosis among adults, after remaining almost stationary for at least a century, has decreased about 50 per cent in the last three decades. Nearly all of this decrease is due to better knowledge of the modes of its dissemination and of the efficacy of rest, diet, and fresh air in its treatment.

But statistics show convincingly that children have not shared in the fruits of this partial victory. Tuberculosis kills to-day as many children of school age as it did fifty years ago. This is made clear by the following table from Kirchner, which shows, for various ages, the average annual loss of life in Prussia from tuberculosis for each 100,000 living: —

TABLE 18

Age in years	Average for females	
	1876–1880	1899–1903
0– 1	18.3	16.5
1– 5	13.	12.
5–10	3.2	3.8
10–15	3.6	3.7
15–20	8.7	7.1
20–25	13.5	10.8
25–30	19.2	12.3
30–40	22.1	12.
40–50	19.	10.
50–60	16.5	10.2
60–70	21.5	11.4

The mortality from tuberculosis below the age of 20 years is thus seen to have remained practically stationary from 1876 to 1903, while for other ages the same period shows a remarkable decrease.

Phillips (6, p. 192) presents the same finding for Scotland and concludes that the school plays an astounding part in increasing the liability to tuberculosis. His figures comparing the mortality from tuberculosis in 1905 with that in 1891 show a slight increase during this period for the ages 1 to 4, a decided increase from 5 to 9 years (8.75 per cent), and a very great increase from 9 to 14 (17.39 per cent).

The extent of the mortality among children of school age from tuberculosis, as compared with that from so-called "children's diseases," is far greater than is usually believed. This is shown for ages 1 to 15 (for Prussia) in the following valuable table from Kirchner. The table shows what percentage of the deaths occurring at any particular age are due to each of the diseases listed.

TABLE 19

Cause of death	Years					
	0–1	1–2	2–3	3–5	5–10	10–15
Whooping-cough	3.8%	7.7%	5.85%	3.84%	1.46%	.18%
Measles........	1.45	8.32	7.63	5.49	2.87	.53
Diphtheria.....	.62	4.44	9.50	14.51	12.92	4.29
Scarlet fever....	.32	2.41	7.98	11.67	13.37	6.34
Tuberculosis....	1.33	4.32	6.18	8.73	12.40	30.03

This table is for girls. The figures for boys are about the same except that the percentage from 5 to 10 years is 10.11 as compared with 12.4 for girls; and from 10 to

15 years, 18.41 as compared with 30.03 for girls. An examination of the table shows that for the ages 5 to 10, tuberculosis kills about as many children as scarlet fever or diphtheria, and more than three times as many as measles and whooping-cough combined, while for the ages 10 to 15 tuberculosis kills nearly twice as many boys and three times as many girls as the other four diseases combined.

Whooping-cough produces its highest ratio of deaths from 1 to 2 years and takes a relatively unimportant place before the school age is reached. The mortality from measles is highest from 1 to 3 years, low from 5 to 10, and almost negligible from 10 to 15. Diphtheria and scarlet fever show a high mortality rate from 2 to 10, when a rapid decrease begins. Even during the years of school life, a period usually thought to be little productive of this disease, tuberculosis is a more frequent cause of death than any of the so-called "children's diseases."

But the mortality tables do not inform us as to the real prevalence of tuberculosis among children. It is now well established that a majority of children contract tuberculosis before the end of the elementary-school period. This was first revealed by autopsies on the bodies of deceased children.[1] In 1800 such autopsies Ganghofner (6, p. 325) found the following percentages of latent tuberculosis: —

[1] For this purpose, of course, only the bodies of children who have died of other causes than tuberculosis are used.

TABLE 20

460 cases	0–1 year	7.1 per cent
536	1–2 years	16.
476	2–4	24.5
271	4–6	26.9
123	6–8	26.8

Heubner, Cornet, Harbitz, Comby, and Still present similar figures, while some investigations have given even a higher percentage.

If further evidence of the wide prevalence of tuberculosis among children is desired, it can be gleaned in convincing abundance from the results of tuberculin tests made upon apparently normal children.[1] Von Pirquet applied this test to 693 apparently healthy children and found a positive reaction, increasing from 2 per cent in the first year to 35 per cent in the years 7 to 10. Hamburger (quoted in 7) shows that Von Pirquet's figures are much too low. The latter secured a positive reaction in about 9 per cent at 2 years, 50 per cent at 6 years, and 95 per cent at 12 years. Hamburger concludes that tuberculosis is a true children's disease. "Just as everybody goes through measles, a disease which is acquired during childhood, so we can say that almost every one acquires tuberculosis sometime, and mostly during the years of childhood." By the same

[1] The most reliable of the tuberculin tests is the one devised by Von Pirquet, which is made by scratching the skin and inoculating the abrasion with a small amount of tuberculin solution. If tuberculosis is present an inflammatory reaction occurs at the point of inoculation within twenty-four hours. While this tuberculin test of Von Pirquet is not thought to be absolutely infallible, it is believed to be reliable enough to give approximately correct results when used with large numbers of individuals.

test Jacob (quoted in 8) found a positive reaction among 43.9 per cent of 1927 German school children examined; Ito, of Japan, a positive reaction from 43.9 per cent of 246 boys and from 50.5 per cent of 196 girls; Herford (quoted in 7) a positive reaction from 55 to 78 per cent of 2594 English children. The incidence has been found to be about as great in the country as in the city, and to be very high among the children of the best classes.

The proportion of school children diagnosed as tuberculous is, when the tuberculin test is not employed, usually very much less, commonly falling between 1 and 5 per cent. Thus Dr. Squire's examination of 1670 non-selected school children of London reports .47 per cent as definitely tuberculous (pulmonary tuberculosis), .8 per cent as doubtful, and 2.8 per cent as having morbid chest conditions of non-tubercular character. Fraenkel, 1906, reports 1.26 per cent tuberculous among 17,236 school children examined in Berlin (1) and from 8.4 per cent (boys) to 10.5 per cent (girls) as predisposed to the disease. A more recent investigation reports 1.61 per cent of the school children of Stockholm as infected with open tuberculosis.

In the United States, school medical examinations have usually been too superficial to disclose any except the most marked cases, and to quote statistics from such examinations would be misleading. European examinations are much more thorough. Indeed, Grancher (3), of Paris, claims to have demonstrated by improved methods of chest diagnosis, without the use of tuberculin tests, the presence of the disease in from 14 to 17 per cent of non-selected school children. All the school children in an average district of Paris were carefully examined by him and his assistants. Of 438 boys, 126 were held for reëxamination as suspects, and of the latter, 62 (or 14 per cent of all) were finally diagnosed as positively tuberculous. A similar procedure with 458 girls gave 131 suspects and 79 (17 per cent) as positively tuberculous. A third examination of these children confirmed every diagnosis.

These figures seem high, but when we remember that about 12 per cent of our school children later actually succumb to the disease, and that very many others contract it in a severe form and ultimately recover, it does not seem an exaggeration to say that at least 15 or 20 per cent should be thought of as definitely predisposed to the disease. Kelynack places the number at 25 per cent.

What is the essential significance of the above statistics? It would perhaps be rash to infer that all who contract the disease are in very serious danger of dying from it. The fact that by far the larger number recover promptly and without suspicious symptoms shows that the human body has already acquired a high degree of resistance. A large minority, however, retain the infection in latent form, and often, after the lapse of many years, succumb to it. It is now believed by the best authorities that many, if not most, tubercular infections date back to the early years of childhood. The pulmonary infection which first becomes evident in adult life is probably not usually a primary infection, but a continuation of infantile tuberculosis. Experiments with animals indicate that once infected an animal cannot be reinfected, even though the primary infection remains and later causes death. Hence, since nearly all children have been proved to be harboring infection before the years of adult life, those who first show the symptoms of the disease as adults are in all probability victims of the outbreak of an old and latent infantile infection.

Dr. Pollak (quoted in 4) seems to have proved by the study of case histories that an older child with "manifest" symptoms has in every case lived in close personal contact with a tuberculous person in infancy, most frequently in the first three years of life. It is also shown that the earlier in infancy the primary infection was contracted, the less favorable are the chances of recovery.

The disease once contracted by the child, there are four possibilities: (1) spontaneous recovery without manifest symptoms of any kind; (2) it may become manifest and lead quickly to death; (3) after becoming manifest the disease may disappear after more or less evident illness; or (4) there may be a relapse after apparent recovery. Which of these events will follow is determined both by the native vitality of the individual and by the circumstances of his environment and mode of life.

The seat of infection in children of school age is less often in the lungs than in the lymphatic glands or bones. The swollen cervical glands, so often considered a symptom of little importance, are frequently, if not usually, tuberculous. Adenoids and enlarged tonsils are also often infected. Of 905 adenoids examined by Dr. Peters (6, p. 55), 45 per cent were found infected. Uicoll found 10 per cent.

It is estimated that tuberculosis of the bone has made cripples of at least 150,000 people in the United States. This form of the disease attacks most frequently the spine, hip, or knee. Of 1000 cases analyzed by Young (6, p. 174), 416 involved the spine, 421 the hip, and 103 the knee. It is tuberculosis of the spine that produces the deformity known as hunchback, while active infection of the hips and knee are familiar to all as "hip-disease" and "white-swelling." The most frequent onset of bone tuberculosis is between 2 and 9 years; of the spinal cases, 72 per cent begin between 1 and 5 years; and of the hip cases, 64 per cent between 2 and 6. About 20 per cent of the bone cases die either during the progress of the disease or within a few years. The "expectation of life" is considerably below normal for spinal tuberculous cripples (6, p. 189).

With tuberculosis of the bone, as with the pulmonary form of the disease, the greatest stress should be placed upon early diagnosis. When treatment is begun early enough, recovery is almost sure, and in a majority of cases without resulting deformity. But it is stated on good authority (6, p. 189) that in 95 cases out of 100 of spinal tuberculosis deformity has set in before the diagnosis has been made. The child with frequent or occasional pains, slight rigidity, or tenderness in the joints should be an object of suspicion.

As regards the sources of contagion, authorities consider the home the most important. Kirchner, Grancher, and Walsh have followed up a number of severe school cases, and have almost invariably found tuberculosis or squalor, or both, in the home environment. Milk may be an occasional source of infection in early infancy, but is now thought to be responsible for relatively few cases among older children. Only a few can be directly of school origin for the reason that tuberculous school children seldom have the disease in the open form and are thus not sources of danger to their fellows. Practically the only school danger comes from the teacher herself. From 1 to 3 per cent of teachers have been found tuberculous. There are probably a quarter of a million school children daily exposed to infection from this source in the United States.[1]

Means of prevention

No plan of campaign against tuberculosis can possibly meet success which does not center its main efforts upon infancy and childhood. Since, according to Hamburger, the pulmonary tuberculosis of adults is only the tertiary form of a primary infection which occurred in infancy, and of which the gland and bone infections of school children are the secondary form, the logical and most effective method would be to prevent the infection of infants by removing them from all contact with

[1] See Lewis M. Terman: *The Teacher's Health.* 1913, pp. 138.

persons who are tuberculous. But this would involve the breaking-up of family life to an extent which present laws do not permit or public opinion sanction. Something can be done by providing free public hospitals and camps in which the tuberculous patients among the poorly housed could be isolated. Housing laws, of course, accomplish something by lessening the chances of infection. What many a child most needs to keep him well is room to live, sunlight, air, and the opportunity to play. Poverty that condemns children to a life of squalor and to insufficiency of nutrition harbors and protects the disease against the most determined assaults of the hygienist crusader; and there is yet no formula for the abolition of poverty. The protection of children from tuberculosis is a problem whose solution can be attained only by the wholesale coöperation of medicine, politics, statesmanship, industrial reform, and education. The most effective of these is education.

Infection with tuberculosis in early childhood is so common even among the more fortunately situated classes that probably for many years to come a considerable proportion of children will have contracted the disease before the beginning of school life. We cannot place our main reliance, for the present, upon the prevention of the primary infection. Instead we should go on the assumption that when the child enters school he has probably suffered a primary infection. We should then proceed so to order his life, by means of the school, that the secondary form of the disease will be forestalled. If we fail in this, we should concentrate our efforts to bulwark the body against the tertiary, or "open," form of the disease. It is foolish to begin our expensive operations with the third and last act of the drama.

What the school can accomplish

The school offers the only satisfactory opportunity for an early diagnosis of the tubercular predisposition. The utilization of this opportunity to the fullest would gives us an enormous strategic advantage. Unfortunately it has not been utilized. Our school medical examinations are entirely too superficial to uncover anything less obvious than the open case or the most extreme predisposition. The work of Grancher and his pupils shows how inadequate and misleading is the average school medical report which returns no more than 1 per cent of the pupils as showing symptoms of tuberculosis.

When the tuberculous or pre-tuberculous child has been found, the leading aim of the school thereafter should be to fortify his body against the disease. Everything else should give way to this. Teaching and instruction should thereafter be considered entirely incidental to this one central aim. This should include provision for appropriate nourishment (to be supplied by the school if it is not forthcoming at home), open-air schools, rest and sleep, abundance of outdoor play, a specially adapted program of instruction, and constant medical oversight. The home should be visited and parental coöperation enlisted in every possible way. The school physician should make frequent reëxaminations, including blood tests, and should keep in the closest touch with the teacher and school nurse. When vacation comes it is folly to dump the child back into his hovel or cramped tenement "home." Instead he should be taken to the country or be given the privilege of the "vacation colony."

Assuming that the tuberculous child has been brought safely through to the end of school life, one more obligation remains; namely, a final and thorough physical examination followed by some earnest vocational advice which will insure the choice of a trade or a profession least dangerous to the person of tubercular tendency. The child should be given a card on which the most important occupations are listed in the order of danger from tuberculosis. The cause of hygiene and the economic welfare of the country could both be served by persuading children of tubercular tendency to take up farm life in preference to shop or office work in the city. Vocational guidance will find its most scientific basis on the side of physical diagnosis and medical advice.

In countless other ways the school can safeguard the children so as to forestall the secondary and tertiary stages of the disease. To accomplish this most effectively the following measures are necessary: —

(1) Adequate instruction of children in the main principles of personal hygiene. Instead of being reserved for incidental treatment, hygiene should be considered as one of the three or four most important subjects of the course of study from the kindergarten to

the university. A large share of hygiene instruction could well be devoted to the causes and prevention of tuberculosis, since the instruction most effective for this purpose will be either directly or indirectly applicable to the prevention of other diseases.

As Gulick has emphasized, the special instruction on a topic like tuberculosis should not be crowded into one or two years of school life. Information thus hurriedly acquired is not assimilated in any vital way. The subject should be taken up year after year from different angles and by methods adapted to the child's stage of development. In the earlier years the instruction should take the form of the inculcation of habits and ideals of cleanliness which are inimical to the disease. At this stage it is not necessary, or even desirable, to impart specific information regarding the nature of tuberculosis, nor need it even be mentioned by name. By the third or fourth grade, more specific instruction should begin and should be planned so that each year some new aspect of the subject is made thoroughly familiar to the pupils. In one grade the stress could be placed upon the value of fresh air and the ordinary means of obtaining a maximum amount of outdoor life. In another grade the relation of tuberculosis to alcohol could be made prominent. At another time, the influence of fatigue, ill-nourishment, etc., and still later the social and economic aspects of the problem. Not all the necessary knowledge of the related physiology and anatomy can be assimilated in any one grade, and accordingly this should be worked in piecemeal as the child's ability to understand it develops. Thus, year after year, while taking care to avoid the inculcation of an unreasoning fear, the instruction can be driven home and the child made to appreciate the necessity of so ordering his life as to insure a reasonable security from the disease.

(2) In order to pave the way for the improved methods of teaching hygiene in the public schools, another reform is first necessary. The teachers themselves will have to receive more adequate instruction. Here the coöperation of the normal school is necessary. Reform should logically begin at the top. Meanwhile, something can be done by superintendents and school physicians to educate the rank and file of teachers-in-service along this and other lines of personal and social hygiene.

(3) The course of study and program of instruction also need to be reformed to accord better with the psychological laws pertaining to economic methods of learning, fatigue, the hygienic use of the school day, etc. If by improved methods one or two hours per day can be saved from instruction in writing, spelling, arithmetic, etc., without loss to the child in those subjects, hygiene demands that part or all of the time thus gained be devoted to other activities more conducive to health than the usual sedentary occupations of the school. The latter could be limited to two hours in the lower grades, to three hours in the middle grades, and to four hours in the eighth grade, without loss. Play, rest, manual work, gardening, and elementary agricul-

ture could fill up the remainder of the school day, to the child's great profit both physically and mentally. Overwork of the predisposed child, in school or out, is a potent influence transforming a latent into a manifest infection. When animals which have been experimentally inoculated with the disease are compelled to overwork in a treadmill, they succumb much more quickly than those which are not so treated.

(4) The widespread interest in playgrounds should be still further encouraged. The nation has not yet one tenth enough. In the city the employment of playground instructors should be as much a matter of course as the employment of the classroom teacher. Normal schools and teachers' colleges have here one of their most important functions. Every outgoing teacher should have had some instruction in the psychology and hygiene of play, and some practical experience in the supervision of children's games. The special play teachers, of course, need a thorough grounding in all aspects of the subject. There can be no ideal school without its spacious playground and its agricultural plot.

(5) Baths should be installed in public schools and their use encouraged. These will come to be looked upon as more necessary in proportion as play and other out-door activities are introduced into the school day. School baths do more to instill habits of personal cleanliness than any amount of didactic instruction. The shower bath should be regarded as one of the necessities in school architecture, just as we now look upon

toilet conveniences, lavatories for the hands and face, drinking-fountains, etc.

(6) Seating and posture must receive attention if the lungs are to be normally developed. The experiments of Badaloni are here in point.[1] Idle lung tissue must be reduced to a minimum, for that is the kind tuberculosis prefers to nest in.

(7) School buildings, until we can contrive to get along without them, should be better ventilated and should be kept free from dust. It is useless to expect the linings of nose, throat, and lungs to remain healthy as long as the air passages are kept in a constant state of irritation by the mineral dust of the average schoolroom. Schoolrooms can be kept practically free from injurious dust.[2]

(8) Since tuberculosis is so intimately related to the alcohol problem, the school finds here an additional motive for enlisting in the cause of temperance.

(9) School dental and medical clinics for free treatment are an indispensable measure in the fight against tuberculosis. Only by this means will the host of minor ailments, so important in the prevention of tuberculosis, be given the appropriate amount of attention. For want of attention to the minor ills many children are now lost. The child has as much right to the medical treatment which will make his health and education possible as he has to the education itself. The amount of medical and dental treatment received by children,

[1] See page 397.

[2] See Hoag and Terman: *Health Work in the Schools.* 1914. (Chapter on "School Housekeeping.")

in proportion to that which is needed, is about as inadequate as their education would be if there were no public schools. The requirements of the body are as much a matter of social concern as the needs of the intellect. Neither can safely be left to private initiative and to the business enterprise of quacks.

(10) As already stated, probably a quarter-million children could be protected from the danger of contagion at school if the tuberculous teacher were eliminated. By means of a system of retiring allowances this could be done without injustice to any teacher.

(11) In view of the very much greater incidence of tuberculosis among girls than among boys in the earlier years of adolescence, it seems highly desirable that the hygienic regimen of the adolescent girl be improved. This would doubtless necessitate reforms both in the school and in the home. Special attention should be given to the health instruction of girls, not only for their own good, but also because as teachers, mothers, and keepers of the home, they will always and inevitably play a leading part in the hygiene of the succeeding generation.

(12) The prevalence of malnutrition has been treated in chapter VIII. It need here only be pointed out that our tuberculous patients are recruited largely from the 15 or 20 per cent who as children presented the symptoms of malnutrition. These children must be reached in some way, and it is doubtful whether there is any way which does not lead through the school.

(13) It has been shown that the period of convales-

cence from an attack of whooping-cough or measles is often marked by the passage of a primary infection into the secondary stage, or of a secondary infection into the tertiary. Hence weakly children need to be watched more carefully and permitted a longer period of rest than is customary in such cases. Teachers and parents should have special instruction on this point.

It is impossible to forecast every detail of the school's contribution to the warfare against tuberculosis. We must emphasize, however, that little ground will be gained unless all social agencies coöperate in a broad way and use every resource at their command to safeguard the child. Private philanthropic measures, good as far as they go, can never cope with the problem in any effective way. Because the school offers the chief means of access to children, it is necessary to make it the main battleground in the conflict.[1]

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CHAPTER X

THE PHYSIOLOGY OF VENTILATION

"Shades of the prison house begin to close upon the growing boy."

Air is food as truly as meat or bread. We feed the stomach at most but three or four times a day, the lungs about fifteen times a minute. We are nice and discriminating about the food which we offer the stomach, but we complacently consume lung food which is clouded with dangerous mineral dust or filthy with organic matter derived from the skin, teeth, and mucous membranes of other persons. To a sense of smell of ordinary delicacy a first whiff of typical schoolroom air is likely to be found nauseating and stifling, like the morning air of an unventilated bedroom.

The immediate effects produced by ill-ventilation are headache, drowsiness, lassitude, faintness, dizziness, nervousness, and in extreme cases even death.

After the battle of Austerlitz, of 300 Austrian prisoners who were herded in a small, ill-ventilated prison, 260 were killed by impure air. In1848, about 100 steerage passengers of an English ship were locked up in a room 18 by 11 feet, without ventilation. When, a few hours later, an exit was forced amid scenes of frenzy and violence, 72 were found dead.

The indirect and remote effects of chronic exposure to unsuitable air are not so well known because they are not so spectacular, but they are none the less real. Bad ventilation is a factor in the production of nearly all kinds of diseases which have their seat in the respiratory passages, including tuberculosis, pneumonia, diphtheria, colds, laryngitis, pharyngitis, nasal or bronchial catarrh, hypertrophied tonsils, and adenoids. Imperfect aeration of the blood causes general debility. This means lowered resistance to fatigue, to disease, and probably also to temptation. Neither physical nor moral victories go to the anæmic.

Red blood is at a premium everywhere: in the pulpit, in the judge's chair or the jury's box, in the doctor's office, at the superintendent's desk, in factory or mine or battle. It protects us from tuberculosis, pneumonia, influenza, and many other diseases, or enables us to win in the fight against them when they have secured a hold. Hardly a disease is known which may not be more or less favorably influenced by the open-air treatment.

What is the secret of this? In order to answer the question it will be necessary to consider briefly the physiological aspects of the ventilation question.

Our ventilation problems have been turned over to the mechanical engineer, but he has not solved them and cannot solve them alone. Ventilation is first of all a physiological problem, only secondarily and incidentally one of mechanical engineering. The real object is not schoolroom ventilation, but body ventilation. This is a physiological problem.

The ventilation "expert" has assumed that indoor air is healthful when it is kept at a given uniform temperature (about 72 degrees), when the carbon-dioxide is kept below three parts in ten thousand, and when the exchange of air is effected without perceptible drafts. There are ventilating systems on the market which fulfill these demands and which are often spoken of as ideal. But there is no scientific evidence that a schoolroom ventilated in this way is more healthful than one which has to depend entirely upon window ventilation. On the contrary, the experimental evidence seems to prove that no system of mechanical ventilation has succeeded in making indoor air healthful. Recent physiological researches on this point even suggest the conclusion that the "ideal" ventilation above described is, in its ultimate effects upon the human body, anything but ideal.

The physiology of respiration

In order to locate the engineer's fallacy it is necessary to review some elementary facts pertaining to the physiology of respiration.

(1) All life processes involve an interchange of gases. In one-celled animals this interchange occurs directly through the cell walls. This is not possible for all the cells of the human body, because most of them are too far removed from the source of supplies. Oxygen must be carried to them and gaseous wastes must be sewered away. Therefore we are furnished with lungs and the blood, which work together for the aeration of the farthermost living cell, the one by furnishing the

means of intake and outlet, the other by serving as the agent of distribution and elimination.

The lungs, with their millions of air cells (variously estimated at from 4,000,000 to 700,000,000), afford, when extended by inspiration, not far from 1350 square feet of surface available for the absorption and elimination of gases. The oxygen is combined with the red corpuscles of the blood and carried to every part of the body. In similar manner the blood transports carbon-dioxide and other wastes from every living cell to the lungs and there rids the body of them.

(2) This interchange of gases is by no means a local problem for the lungs alone. The lungs may be fully developed and healthy, but if the blood be deficient in hæmoglobin (the oxygen-carrying element of the red corpuscles), the cells of the body gradually suffocate, just as the inhabitants of a city would famish if the distributing mains from the only available water-supply were to become permanently clogged. An army's commissary may be ever so well filled, but if its communication with the army is blocked, the army cannot live and fight.

(3) Good lungs and pure air are further supplemented by the action of the heart. We breathe as much with the heart as with the lungs. With a strong heart and plenty of healthy oxygen-carriers in the blood, a person need not be concerned about the size of his lungs. Other conditions being favorable, the lungs are nearly always large enough to accomplish their work; and however large they may be, their effi-

ciency is strictly dependent upon the freight capacity of the circulatory system. Large lung capacity does not give increased resistance to tuberculosis. The danger lies, not in lungs which are naturally small, but in unused lung tissue.

(4) But heart, blood, and lungs together cannot force oxygen upon tissues that are not oxygen-hungry. Proverbially you can lead the horse to the trough, but you cannot make him drink. In increasing the hunger of the tissues for oxygen, nothing else is as effective as muscular activity. The active sparrow throws off ten times as much carbon-dioxide in proportion to body weight as the sluggish toad, the boy of 10 years 40 per cent more than the girl of the same age, the youth of 19 years 20 per cent more than the old man of 60. We produce 50 per cent more carbon-dioxide while walking slowly than while at rest, and nearly fifteen times as much while laboring in a treadmill as when asleep. Changing the rate of ordinary walking from two miles to three per hour increases the production of carbon-dioxide nearly 50 per cent. In the person of sluggish habits metabolism languishes. One who never exercises actively is literally only half alive. A perfectly ventilated schoolroom is of little avail for children who are held to sedentary book work for six or seven hours a day.

(5) Breathing itself is active, not passive. The air does not rush into the lungs and expand them, but the muscles concerned in breathing must exert themselves at each inspiration to enlarge the thoracic cavity. If

these muscles are not amply nourished and kept in trim by occasional exercise of more than average severity, they grow weak and lose in scope of movement. This means superficial breathing, a disproportionate amount of idle lung tissue, blood insufficiently aerated, and general weakness. Again we see that body ventilation is impossible in a life of inactivity.

(6) The air in the innermost lung cells, where the interchange of oxygen and carbon-dioxide takes place, is never purified directly. The lungs are not emptied and filled at each expiration and inspiration. If the lung capacity is 3500 cc., the "tidal air," or that which is expelled at each expiration, amounts to about 500 cc. (one seventh). Of the remainder, about one half, or 1500 cc., can be expelled with special effort. This is "reserve air." The other 1500 cc., the "residual air," remains absolutely stationary against the alveolar membranes. From it the blood gets its new supply of oxygen and into it discharges its excess of carbon-dioxide. The residual air is therefore always extremely impure. Compared with tidal air, it is always deficient in oxygen and foul with waste products. The residual air cannot possibly be purified by a few deep breaths of fresh air. Still less can we aerate the whole body in this way. Ten minutes spent in breathing exercises before an open window may do the muscles of the thorax a little good and act as a wholesome moral tonic, but this is not a substitute for a day of normal activity in the open air. As well might the long-distance runner substitute finger exercises for his training. Vigorous

bodily activity impels the rapid production of red corpuscles and the formation of hæmoglobin. We breathe with the whole body (especially with the muscles), not simply with the upper one seventh of the lungs.

(7) Except in extreme cases, the healthfulness of indoor air is not influenced by the changes which occur in its chemical composition. The worst ventilated schoolroom is never deficient enough in oxygen for this, in itself, to constitute the slightest menace to health. Always more oxygen is available than is necessary. Nor is carbon-dioxide the criminal it was once believed to be. There is never enough of it, even in an underground bakery, to produce any discoverable effects. The normal amount in the atmosphere is .03 per cent, and the proportion never goes beyond .4 per cent in the worst ventilated schoolroom. But experiments prove conclusively that it requires about ten times the latter amount to produce any noticeable effect, so long as the air is normal in other respects.

As already indicated, the air which we really breathe is not the air in the room, but the "residual air" which lies next to the alveolar membranes of the lungs. But the residual air always contains 5 to 6 per cent of carbon-dioxide, regardless of the degree of purity of the air which is inhaled. It is evident, therefore, that carbon-dioxide cannot be guilty of the crimes which have been charged against it.

(8) The more recent theory, that the injurious effects of bad ventilation were due to the presence of organic poisons in expired air, has, in all probability,

no more foundation than the carbon-dioxide theory. The experimental results of Brown-Sequard and d'Arsonval, which were thought to prove the toxicity of expired air, are now known to have been due to imperfect experimental procedure. While the air of occupied rooms may contain organic poisons in minute quantities, the numerous experimental studies which have been directed upon the problem do not justify us in believing that under any ordinary conditions these are great enough in amount to produce any injury.

Another theory was that the evil effects experienced from breathing the air of crowded rooms result from the reflex influences produced by odors, which were thought to induce changes in respiration, circulation, heat production, and nutrition. This theory, also, is rejected by the best authorities.

Every one knows, however, that confinement in ill-ventilated rooms is unhealthful. What is the source of the injury?

Air currents, temperature, and humidity

These are now believed to be the important factors in ventilation; not air poisons or excess of carbon-dioxide. They produce their effects chiefly through their influence on the heat-regulating mechanism. It is impossible to understand the principles of good ventilation without consideration of the body's thermal phenomena.

Whatever the temperature of the air around us, our bodies must maintain a temperature which is approximately uniform. Heat loss and heat gain must exactly balance.

The heat of the body is produced in the same way as the heat of the furnace or stove, i.e., by oxidation. Our food is our heat fuel. When the body is too rapidly cooled, heat production is hastened by increased oxidation. This acceleration is most readily brought about by an increase of muscular activity. In cold weather our muscles "tone up" in a condition of partial contraction, and at the same time the circulation becomes more vigorous. In hot weather, when the danger is on the side of too great heat production, our muscles relax and we become languid.

But the body's thermal balance could not be kept up merely by alterations in the rapidity of heat production. Means are provided also for corresponding changes in the rapidity of heat loss.

The body loses heat in three separate but mutually supplementary ways; by radiation, by conduction, and by the evaporation of sweat. The amount lost by radiation depends upon the temperature of the surrounding air, upon the clothing worn, and upon the amount of blood in the vessels near the surface. The amount lost by conduction depends upon all these factors and in addition upon the humidity and movements of the surrounding air. The amount lost by evaporation depends upon a number of factors, relative humidity and air currents being among the most important.

To recapitulate, the heat of the body is kept uniform by a marvelously delicate system of balances involving the following mechanisms: (1) Means for increasing or decreasing the rate of heat production, and (2) means for regulating the rate of heat loss. The latter is accomplished chiefly in two ways; (*a*) by regulation of the amount of blood carried to the skin, and (*b*) by regulation of the activity of the sweat glands.

Which of the above means will be brought most effectively into play in any given case will depend entirely on the special conditions. If the air is cold and damp, the body tends to lose heat too rapidly by radiation and conduction. Accordingly, the blood is driven inward by vasomotor constriction of the blood vessels of the skin, and both conduction and radiation decrease. The sweat glands also cease their activity so as to prevent still further loss of heat by evaporation. At the same time the muscles tend to partial contraction so as to increase heat production.

On the other hand, when heat is accumulating too rapidly, whether because of vigorous activity or excessively high atmospheric temperature, vasomotor control fills the skin with blood so as to increase radiation and conduction, and the sweat glands simultaneously hasten their work. If the air is as warm as the body, no heat can be disposed of by radiation or conduction, and perspiration becomes our sole defense against overheating. If the air is excessively humid or still, even this defense is destroyed and heat apoplexy may result.

Any condition which interferes with the working of this complex thermal mechanism is likely to produce injury. The disturbances which actually occur are of two kinds: external and internal. The external include chiefly such factors as unsuitable temperature or humidity, and the absence of air currents. The internal disturbances include unsuitable activity of the sweat glands, of the heat-producing mechanism, and derangement of the vasomotor reflexes which regulate the supply of blood sent to the skin.

Of the external influences, temperature and humidity are the most important. Their physiological effects are best demonstrated by means of air-tight cabinets such as those used by Paul, Brown-Sequard, and Hill. One or more persons are inclosed in the cabinet, and the effects of various conditions of humidity, temperature, and air movement upon the inmates are noted.

Dr. Paul found that when the temperature of the cabinet was kept at sixty degrees, the experimenter could stay in the cage four and a half hours without noticeable symptoms, although long before the close of the experiment the carbon-dioxide content of the air in the cabinet was far higher, and the oxygen content far lower, than is ever the case with the worst ventilated schoolroom. But at seventy-two degrees, only a few minutes were required to produce feelings of mental dullness, headache, vertigo, and faintness. Before long the body temperature rose three degrees. Then an electric fan was started and the symptoms almost immediately vanished.

Hill's experiments with air-tight cabinets proved that when the air was kept cool and in motion the subjects suffered no ill effects even when the proportion of carbon-dioxide was twenty times as great as it ever is in badly ventilated houses. At this point, the oxygen content was so low that candles would not burn and the inmates could not light their cigarettes with matches. When the temperature of the air was suddenly increased by means of an electric stove, the usual symptoms of rapid heart-beat, increased body temperature, and feelings of distress quickly made their appearance. Electric fans were then started and the passage of swift air currents over the body brought almost instant relief.

Hill also imprisoned guinea pigs for periods as long as fourteen weeks in tight cages where the proportion of carbon-dioxide was from fifteen to thirty times above the normal. The guinea pigs throve beautifully in spite of the "bad" air as long as their cages were kept cool, dry, and clean.

In other experiments Hill was able to prove that breathing the hot and vitiated air had nothing whatever to do with the symptoms. Persons who stood outside were able to breathe the vitiated air of the cabinet tubes without experiencing any ill effects. Conversely, when those inside were suffering extreme symptoms due to the overheated and stagnant air of the cabinet, they experienced no relief from breathing the pure, outside air through the tubes. Only the fans and the lower temperature brought relief. The explanation is as follows: If the air is not in motion, that next to the body quickly becomes saturated and refuses to take up additional moisture. It acts as a "steam jacket" enveloping the body and causes languor and depression. The perspiration is not evaporated and, as the Germans say, the body is then not able to "unwarm" itself. The pulse is accelerated, more blood is sent to the skin and less to the viscera and brain. The blood vessels of the skin dilate, the blood pressure is lowered, and extra work is thrown upon the heart. When the dead air is set in motion by a fan, the steam jacket is dissipated, the sweat evaporates, the circulation becomes more normal, and we are refreshed.

Air currents and perceptible variations of temperature are the essence of good ventilation. The "imperceptible ventilation" for which the mechanical engineer so industriously labors is beginning to look like a delusion and fraud. The thermostat [1] has well been called an "invention of the Devil." It is largely our prejudice against air currents and variable temperature which makes our indoor life so unhealthful.

By some hundreds of thousands of years of outdoor living, before houses were invented, man's body became so adapted as to thrive under the stimuli of air currents and changing temperature. Our few hundred years of life in the stagnant atmosphere of stuffy rooms have not yet brought the physiological adjustment necessary to make such life healthful. Out of doors,

[1] A mechanical arrangement which works automatically so as to maintain a uniform temperature of the room.

even in a very mild breeze, the body is bathed in at least five hundred cubic feet of air per minute. It enjoys complete "perflation."[1] Open-air schools permit perflation; others do not. Indoor schools which have to depend on windows for their ventilation may be more healthful, in case the windows are frequently thrown open to admit a fresh supply of cool air, than those with the most improved system of artificial ventilation.

Normal and complete perflation can injure no one whose physical defenses have not been weakened by coddling. Continued sedentary life does this. As stated by Hill, "Our circulation is contrived for a restless, mobile animal" (3). Life indoors both lowers vitality and increases the opportunities for contagion. Persons who have been weakened by hot-house culture have to take special precautions with clothing in making the transition to outdoor life.

Instead of fleeing from drafts, we should seek them. As long as we are healthy, it is only the little draft, which cools but a small part of the body, that is injurious. The remedy for draft, therefore, is more draft, coupled with the healthy circulation that comes from sufficient exercise. Even the sickly pupils of the open-air school do not catch cold.

Immunity from colds depends largely upon the healthy action of the automatic vasomotor reflexes of the skin. When the body needs to be cooled, the walls

[1] Perflation refers to the rapid movement of air over the entire surface of the body.

of the blood vessels in the skin relax and become distended with blood so as to permit more rapid loss of heat by radiation and conduction. When heat needs to be conserved, the blood is driven from the skin to the interior by the contraction of the surface blood vessels. This process is reflexly controlled by a delicate nervous mechanism which causes the walls of the blood vessels to contract or relax according to the kind of signal received.

Hardly anything is more to be desired than a healthy condition of these vasomotor reflexes. When they are normal, drafts do not harm us, and we can expose ourselves with impunity to sudden changes of temperature. The important fact to be noted is that the vasomotor apparatus can be kept normal only by practice. If we close all the windows to prevent drafts and install a system of heating which keeps the temperature of the air at exactly the same point, the walls of our surface blood vessels grow lax from disuse and forget how to act. Then when the draft is encountered, or when the room is cooled a little below the customary temperature, or when we go out of doors lightly clad, the body is too rapidly cooled. This is the way we train our children to catch cold. No other results need be expected until the windows and doors are thrown open and the children are permitted to live and learn under normal conditions of air and with less suppression of physical activity.

The heart, the capillaries of the skin, the sweat glands, and the mechanism for producing heat by increased oxidation must all function together in order to keep the body at a constant temperature, and the exact participation of each factor varies according to the temperature, humidity, and currents of the surrounding air. The balanced coöperation of all these reflex controls cannot be maintained except under fairly normal conditions of life. The sedentary life of the school disrupts all of them. The mechanical system of ventilation at best can ventilate only the schoolroom, while the real end of school ventilation is the aeration of the individual cells of the child's body. This end will not be attained until we fill the schools with perceptibly moving air of ordinary outdoor humidity and of a reasonably low, but not quite uniform, temperature; nor will it be attained until we permit the child to lead a life of normal activity.

Another of the serious evils of schoolroom air under artificial methods of ventilation and heating is deficient humidity. When air of 30° F. at a relative humidity of 60 or 70 per cent is heated to 72°, the relative humidity is greatly lowered and the drying capacity of the air is increased enormously. On an average winter day the air of the "best ventilated" school may show a relative humidity of only 25 or 30 per cent; that is to say, it is as drying as the winds of the Sahara. Plants less hardy than the desert cactus shrivel and die in such an atmosphere. Why should we expect children to thrive in it?

So great is the drying capacity of warm air at this degree of humidity that it voraciously licks up every available particle of moisture, from the furniture, which promptly cracks and falls to pieces, and from the skin and throats of the children. All the mucous membranes exposed to such air become parched and unhealthy.

As shown elsewhere (p. 200), one important function of the nasal passages is to add moisture enough to the air in its passage to the lungs to raise it almost to the point of saturation. In the desiccated air of the furnace-heated or steam-heated school, this task becomes too great. Diseased conditions of the nose and throat result: catarrh becomes the rule; diphtheria, pneumonia, and tuberculosis are more easily contracted; and it is possible that adenoids and hypertrophied tonsils may sometimes be caused in this way.

When the mucous membranes of the nose and throat are healthy, they produce a germicidal secretion which rids the incoming air of nearly all its bacteria. When changed in texture by air of deficient humidity, the membrane is no longer a "bulwark against disease," but a "host for the culture of germs." "It turns traitor to the body by giving aid and comfort to its enemies."

Another effect of this kiln-drying to which we subject children is to make them irritable and nervous. Self-control becomes more difficult. Outbreaks of temper are frequent. Concentration is impossible.

It has been suggested that some of the evil effects of indoor air may be due to changes which heated and inclosed air undergoes in respect to its electric properties and radio-activity. The physiological effects of radio-activity, however, are yet too clouded in obscurity to enable us to speak with any assurance on this point.

The experimental evidence seems to justify the conclusion that living in stuffy rooms is unhealthful mainly because of the excessively high temperature, unsuitable humidity, and motionless uniformity of inclosed air, combined with the habits of physical inactivity which usually go with this mode of life. If this is correct, we should divert the rich stream of public money now going to the purchase of expensive ventilating systems to other and more profitable ends. It would be a step in the progress of hygiene if we could contrive to get along without school buildings altogether. Where this is not possible we can at least make our schoolrooms into the open-air type by the use of large, hinged windows. The air of the ordinary indoor school can also be made much more hygienic by frequent flushing through opened windows. The latter precaution, in fact, is a necessary adjunct to any system of ventilation.[1]

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CHAPTER XI

THE TEETH OF SCHOOL CHILDREN

The problem

DR. WILLIAM OSLER has expressed the belief that more physical degeneracy can be traced to neglect of the teeth than to the abuse of alcohol. It is undeniable that it affects directly very many more people. Of our twenty million school children, not over one or two million are free from dental disorder of some kind, and of the remainder of the population only a negligible minority.

About one fifth of all the teeth of our school children are diseased. Every day hundreds of thousands of these teeth are aching. Dental caries has been named by Dr. Jessen "the people's disease"; no other is so widespread.

Diseased teeth are thought to be responsible for a vast amount of ill-health, including indigestion, anæmia, general debility, mental and physical retardation, nervousness, and acute infectious diseases. Complications with heart and ear are common. Life expectancy and industrial efficiency depend in no small degree on the condition of the teeth. Moral efficiency and the joy of living may depend, directly or indirectly, about as much on one's teeth as on one's philosophy or religion. Who would not agree with Don Quixote, that a tooth is worth more than a diamond?

Artificial teeth, to be sure, may be substituted for those which nature gave us, but since their mastication efficiency has been demonstrated to be only about one tenth that of natural teeth, they can hardly be considered a satisfactory substitution.

During the Boer War over 3000 English soldiers were invalided home because of defective teeth. Out of 23,000 rejected applications for enlistment in the British army, 5000 were for defective teeth. In 1906, the United States rejected 1000 applicants for the same reason. In one year 1845 soldiers in the French army were sent to the hospital because of disorders of the teeth. Loos examined the teeth of 1000 German soldiers and found an average of 9.6 carious teeth per head. Cunningham and Rose found an average of 7.5 and 6.9 per head, respectively. The German soldiers examined by Port had 27 per cent of their teeth diseased (quoted in 14). These are probably average conditions for adults in Europe and America.

Yet the causes of dental decay are definitely known, tangible, and amenable to control. About twenty millions of dollars, expended in the right way, would put all the teeth of all our school children in order, as far as their present state of disease permits; and an annual expenditure of fifty or seventy-five cents for each child, combined with suitable instruction, would keep them so. Dental decay is chiefly a disease of childhood and youth. If kept in repair till the age of twenty, the teeth should be sound at sixty. Neglected till twenty, teeth with any tendency to decay are beyond hope of salvage.

What examinations of children's teeth have disclosed

Two decades ago the mouth of the school child was to the average educated person an unknown quantity. Even the dentist and physician were not aware of the actual conditions except by inference, for the simple reason that only 5 or 10 per cent of the children ever came to them for examinations. It remained for the school doctor and school dentist to ascertain the real facts.

Examinations of thousands of school children in diverse parts of the world have shown that fewer than 10 per cent of our school children are free from diseased teeth or gums, dental caries (decay of teeth) being the most common defect. The average school child has from three to five decaying teeth. Many investigations report as many as 20 to 30 per cent of all the teeth as affected.

Pedley, in England, examined 3800 children, 3 to 16 years of age, and found 75 per cent with diseased teeth: 12 per cent of all the teeth needed filling or extraction.

Rose's statistics include 157,361 children in Baden and Thüringen, the proportion with diseased teeth running from 79 per cent to 98 per cent. From 16 to 35 per cent of all the teeth were diseased.

In nineteen cities of Schleswig-Holstein, where 19,725 children of 6 to 15 years were examined, only 5 per cent were free from dental caries. Only 218 of these children had ever been treated by a dentist; a little over 1 per cent.

Dr. Jessen's examination of 10,000 school children in Strassburg showed 95.7 per cent of the children to have a total of 102,456 decayed teeth; 52,219 teeth were missing or beyond repair. Of 646 children of kindergarten age, over 85 per cent had diseased teeth, the average number per child being slightly above 4.

Unghavari's statistics for 1000 Hungarian children of 6 to 12 years show 87 per cent with defective teeth: 22.5 per cent of the milk teeth were defective and 7.75 per cent of the permanent.

In Cambridge, England, Dr. Cunningham reports less than 2 per cent of about 3000 children free from dental caries. One third of these children had free pus in the mouth from diseased gums or teeth. The British Dental Association found only 1508 sets of good teeth among 10,500 children, while the average number of unsound teeth per child exceeded $3\frac{1}{2}$. Wallis reports that London school children average 3.9 carious milk teeth and 2.8 carious permanent teeth per child; and that 9.3 per cent of London's school population suffer from alveolar abscess ("gum boil").

In New South Wales, Australia, 7600 children showed 15 per cent of the permanent teeth in a carious condition, and 32.5 per cent of the milk teeth. The average number of carious teeth per child was 4.5.

In New York City 61 per cent of 266,426 children examined had defective teeth, but less than one fourth had ever entered a dentist's office. The Dental Association in Cleveland found 15,061 cavities in the teeth of 2677 children, or an average of 5.6 per child. Boston reports 33,575 school children as in need of dental services, and Brookline 77 per cent. Of 500 New York children who in 1909 applied for certificates permitting them to leave school to go to work, 486 had 2808 decayed teeth; only 5 per cent had ever visited a dentist except for an extraction; and there was not one "decently clean" mouth in the 500 (22).

Smaller cities have given similar results. Superintendent Johnson reports dental caries in 96.9 per cent of 497 children of Andover, Massachusetts, and 31.4 per cent of all the teeth as affected: 22.5 per cent of the children had suffered from toothache within the previous week. Superintendent Reavis examined 407 children in Oakland City, Indiana, and found only 53 with satisfactory teeth — 210 children had from 1 to 4 decayed, and 133 from 5 to 10; 44 children had all four of the six-year molars in a carious condition.

Additional investigations are summarized in the table on page 172.

Our estimate of 90 per cent with one or more defective teeth is therefore conservative. When medical inspectors (as contrasted with dental examiners) report only 40 to 60 per cent with defective teeth, we are to understand that such low figures are the result of superficial inspection without probe and mirror. It should be remembered that when the defect has progressed so far as to be obvious at a hasty glance, the

TABLE 21

Date	Place	Per cent with diseased teeth	Per cent of all the teeth defective
1902	Aschaffenburg	99	33
1894	Berlin	99	31
1897	Freiburg	98	
1897	Halle	94	22
1898	Hannover	89–93	27
1893	Wurzburg	81–85	15
1902	Rudolstadt	93	28
1904	Augsburg	99.4	
1900	Denmark	92	21
1897	Italy	92	
1898	Norway	91	14
1902	Russia	82	
1895	Sweden	86–100	16–36
1900	Switzerland	90–100	14–35

most favorable time for repairing the injury has gone by.

Other conditions very common are protruding upper or lower teeth, jaws meeting at front or back only, teeth in double rows, crowded, etc. As Gant shows, there is more or less gum disease in one mouth out of three, and badly diseased gums in one out of twenty. Uncleanliness is very general, and but a small minority have ever consulted a dentist for any other treatment than extraction.

Johnson's description (18) of the average school child of Andover fits a large proportion of children in every school. "He has twenty-four teeth; eight of them are diseased; sixteen of them are discolored with unsightly accumulation of food and deposits, or else he has some noticeable malformation interfering with mastication; three of the four six-year molars are seriously affected, or else one is already lost and another decayed. He has never put a toothbrush to his teeth, has had toothache more or less during the past year, and has never seen the inside of a dentist's office."

Age differences are marked. Owing to the approaching secondary dentition, more diseased teeth are found in the lower than in the intermediate grades. The smallest number is found at about ten years. In New York the ages below ten averaged one third more carious teeth than the ages above ten. By the age of fourteen, however, so many of the permanent teeth are decayed that the number of defective teeth per child is as great as at six or seven. The six-year molars as a rule begin to decay within two years after their appearance, so that by the age of ten years one or more of them are unsavable.

No sex differences worthy of note have been made out except that the girls are slightly more precocious in dentition, having, after the age of six years, an average of one more permanent tooth than boys of the same age.

Injuries produced by defective teeth

Defective teeth may affect the health of the entire body. The influence is chiefly of four kinds: (1) Decreased power of mastication, due either to decay or irregularities of the teeth; (2) the toxic effect of pus which is absorbed directly into the blood or taken into the stomach and intestines; (3) reflex nervous disturbance due to pain, impaction of teeth, etc.; and (4) the possibility of acting as a breeding-ground and distributing-point for the bacteria which cause acute infectious diseases.

Thorough mastication is prevented by defective teeth. This is due to lack of chewing surface, to irregularities which prevent the teeth from meeting evenly, and to local tenderness. Many children from 6 to 12 years are deprived of half the normal chewing surface. The loss of one tooth always means the functional loss of its opposite. Malformation of the jaws, as in severe cases of adenoids or impaction (crowding), makes mastication practically impossible for many children.

Mastication has a larger function than merely to prepare the food for swallowing. When thoroughly performed it trebles or quadruples the amount of saliva, mixes it thoroughly with the food, and initiates one of the essential processes of digestion, the conversion of starch into sugar. This is the only part of digestion over which we have direct voluntary control.

Mastication also provides a necessary stimulus for the healthy development of the jaw and the growth of the teeth. It has been shown experimentally with rabbits that filing the teeth on one side, so as to confine mastication to the other side, causes maldevelopment of the jaws and of the bones about the nose and the base of the skull. Finally, when mastication is thorough, the teeth tend to clean themselves during the meal; when food is bolted the teeth are more prone to decay.

Toxæmia from the swallowing and absorption of pus is probably the most serious evil of neglected teeth.

Every cavity becomes filled with a mixture of decayed food and bacteria. Miller has segregated and identified more than one hundred different kinds of mouth bacteria, several of which are known to be injurious.

The germs of tuberculosis and diphtheria are often found in dental cavities and are thought sometimes to find their way into the body from this point. Decayed and neglected teeth may in this way cause tuberculosis, scarlet fever, diphtheria, etc. When the teeth are decayed, the tonsils are also more likely to become diseased. Gibson found that 1.8 per cent of the children with sound teeth had enlarged tonsils; 3.7 per cent of the children with 1 to 4 carious teeth; and 5.3 per cent of those with 4 or more.

The following table of results from Brown's investigation confirms Gibson's conclusions (2).

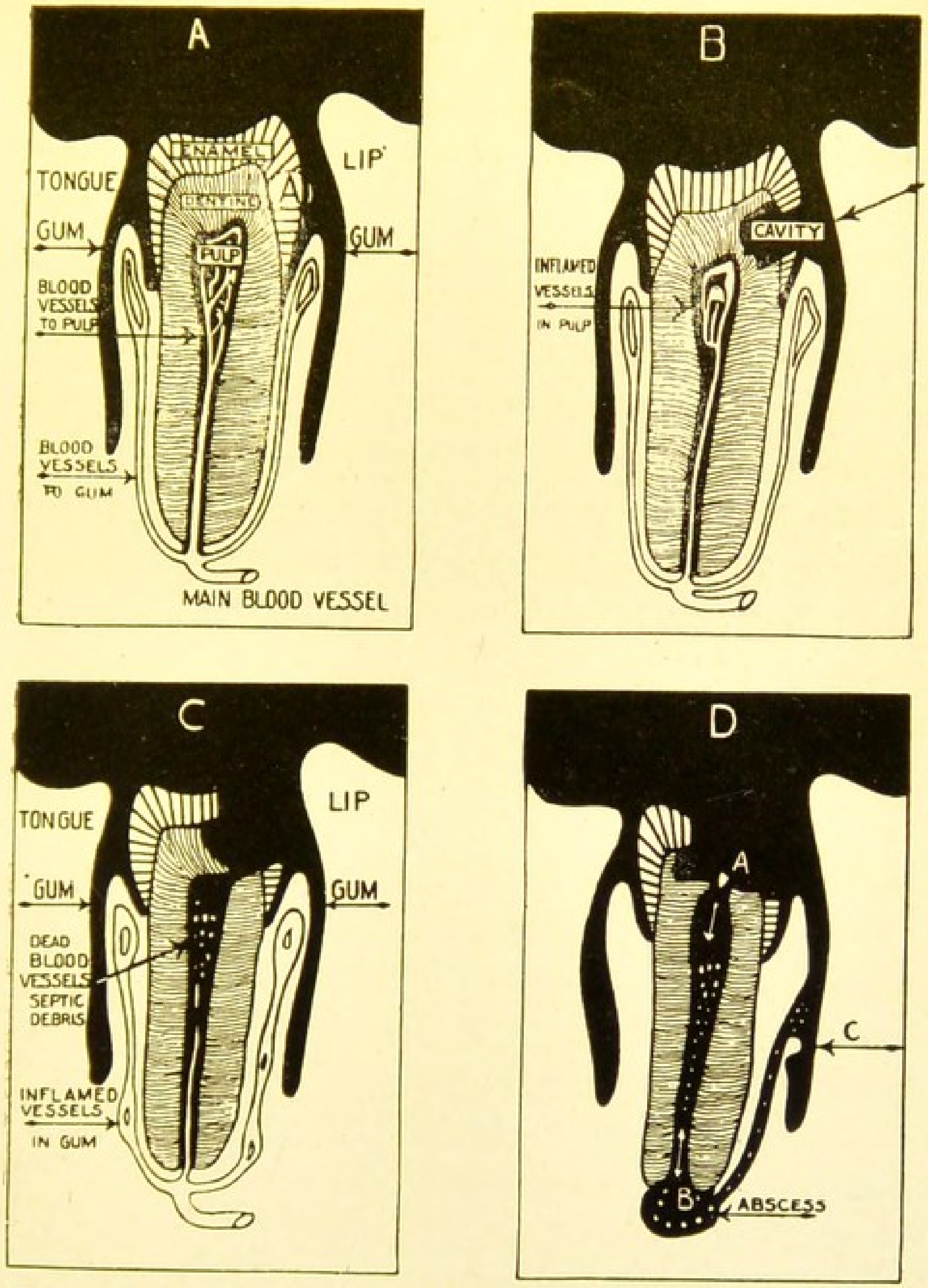
TABLE 22

Number of carious teeth	Number of children	Percentage with tonsils enlarged beyond size of a filbert
0	1803	7.5
1–4	3502	12.5
over 5	1678	16.2

When the decay has spread well into the interior of the tooth, there is always danger that the pus will find its way down through the small opening to the point of the root and there cause the infection commonly known as an alveolar abscess ("gum boil," or "ulcerated tooth"). As shown in the accompanying illustration, decay causes the death of the tooth, gangrene of the pulp, and discharge of pus through the root. This infects the surrounding tissues, causing soreness of the tooth and jaw, until finally the abscess breaks through to the surface of the jaw and allows the pus to escape. A sinus remains, however, which continues to discharge more or less pus as long as the tooth remains, or until it is hollowed out, disinfected, and filled (22). This chronic stage may cause no observable symptoms in the mouth, but the pus constantly finds its way into the remainder of the alimentary tract and into the blood.

Pedley says that the only fit analogy to the chronic gum boil is the serpent's tooth, through the hollow of which the deadly venom is injected into the flesh of its victim. If there is pus in the mouth arising either from decayed teeth or diseased gums, some of it will be mixed with the food during the process of mastication and swallowed. The constant absorption of millions of virulent bacteria causes a septic condition of the intestines, resulting in irritation of the intestinal linings, catarrh, diminished secretions, anæmia, and general weakness. The bacteria may be carried by the blood to distant parts of the body, giving rise to glandular disturbances, inflammation of the heart, etc. The child with extreme oral sepsis is likely to be sallow, thin, and nervous.

The statistics indicate that more than 1 per cent (a quarter-million) of our school children are constantly suffering from one or more ulcerated teeth. Pus may



THE PHENOMENA OF DENTAL CARIES AND THE DEVELOPMENT OF AN ABSCESS (Pedley and Harrison)

A. Normal tooth tissues with commencing caries at A.

B. Cavity formed through enamel into dentine by means of acid bacteria. Irritating pulp and causing swelling of the blood vessels, inflammation and pain.

C. Death of the blood vessels and infection of the pulp cavity with septic germs from the mouth. Inflamed vessels around raising tooth in socket. Pain on biting.

D. Opening into pulp cavity plugged with food or débris preventing escape of decomposing gases at A and forcing a passage at B forms an abscess which discharges at C as a gum-boil.

arise also from other affections of the gums and teeth, and is sometimes found free in the mouths of 30 per cent of the school children (8).

Bad teeth may cause nervousness either indirectly by causing malnutrition or directly from the reflex irritation which aching or crowded teeth produce. Motor automatisms sometimes result and moral self-control may become impossible. Even choreiform movements and epileptiform seizures may occur. Dr. Jessen examined the teeth of 31 stammerers and stutterers and found nearly twice the usual amount of defectiveness (14).

Another investigator[1] examined 58 persons with the skiagraph (an instrument for recording irregularities of the teeth) and found that all who suffered impaction showed signs of nervous disorder. The symptoms ranged from headaches and restlessness to epilepsy, and from mild insomnia to *dementia præcox*. The same author reports that six out of eight such cases recovered upon relief of the impaction. It is significant that in no case was there any local pain, and in only a few, pain of any kind.

Holmes (12) describes an interesting case of moral delinquency and nervous instability which appeared to be the result of impacted teeth. The boy became irritable, nervous, and restless, gradually developing incorrigibility and habits of lying and stealing. He was brought before the juvenile court, treated for adenoids, etc., to no avail. Finally a dental examina-

[1] See *Monthly Cyclop. and Med. Bull.*, November, 1909.

tion was made which disclosed an extraordinary condition of impacted teeth. Treatment was followed by return to nervous control and complete moral reform. While it cannot be denied that suggestion may have been partly responsible for this reform, much clinical evidence has been adduced to show that reflex irritations may be caused by defective teeth. As for toothache, every one recognizes the havoc it may wreak in a few hours on the moral habits of a lifetime.

Defective teeth and mental development

On classifying his pupils as bright, average, or dull, Johnson found that among the children with good teeth there were 13 bright children to 10 dull, while among those with bad teeth there were only 8 bright children to 12 dull. In New York, Ayres found that among 3304 boys 10 to 14 years of age 42 per cent of the dullards had defective teeth, 40 per cent of those with average intelligence, but only 34 per cent of those classed as bright. The average progress made in a given period by the children with good teeth was 4.94 years, and by children with defective teeth 4.65; a loss of about 6 per cent. Dr. Edwin Collins[1] had already claimed a positive correlation between good teeth and scholarship, but offered little data in support of his argument.

The problem involved is one whose solution demands carefully planned research. Only one investigation of this type is available on the issue in question,

[1] See *Nineteenth Century*, July, 1899.

the Cleveland study undertaken by Dr. Wallin and the Oral Hygiene Committee of the National Dental Association (33). The investigation proposed to measure by means of suitable tests the influence of proper care and treatment of the teeth upon the improvement of mental capacities in school children. Forty pupils, "repeaters," were chosen for the tests. The teeth were first put in order and the pupils were pledged to carry out a prescribed regimen of mouth cleanliness and thorough mastication. A prize was stipulated for all who lived up to the rules, and those who became careless were dropped from the test group. The fidelity of the pupils in following instructions was checked up by a visiting nurse. Twenty-seven pupils were available for the entire experiment, which extended over the period of one year. The pupils were first tested in May, 1910, before dental treatment began; at the opening of school in September; and again in May, 1911. The functions tested involved (1) visual memory (reproduction method); (2) rapidity of thought (verbal associations); (3) speed and accuracy in adding digits; (4) association as measured by the "opposites" test; and (5) speed and accuracy of visual discrimination ("A-test"). At the close of the year the pupils showed a fairly uniform improvement in all the tests of approximately 50 per cent. Improvement in school work was simultaneous, only one of the twenty-seven pupils failing of promotion. This is an excellent record, considering that the pupils tested belonged to the retarded class.

A serious defect of Wallin's study, however, lies in the fact that no "control" group was tested. It is therefore impossible to say how much of the observed improvement was due to improved adjustment to the later tests, how much to the added year of age, and how much to the dental treatment and mouth hygiene. Nevertheless, it is significant that improvement in school progress occurred simultaneously with improvement in the tests. Other investigations of this type should be made under better controlled conditions.

Effects upon health and growth

It has been noticed by several investigators that children with bad teeth are extremely likely to be below normal size. Johnson found children with good teeth to average one half-year ahead of children of the same age whose teeth were bad. Wallis (34) says that he has found children with severe oral sepsis (discharge of pus) nearly always under weight and frequently below grade. Henneberg (11) found that children with good teeth gained 5 per cent more in weight and nearly 10 per cent more in height during one school year than children with bad teeth. The following are typical cases described by Colyer (4, p. 168 ff.): —

(1) A girl of 4½ years, considerably below normal weight, was suffering from severe gastro-intestinal trouble. Several decayed teeth were filled or removed, following which the girl gained four pounds in four months, or twice the normal gain for the age in question. (2) A girl of three years weighing 24 pounds developed tenderness of the teeth and lost 1½

pounds in one month (February). The deciduous molars were removed and local treatment applied to the incisors. Within one month the child increased $2\frac{1}{4}$ pounds. By September 3, the weight was $27\frac{1}{2}$ pounds. The incisors now began to give trouble, and the child was seen October 6, when its weight had fallen to $25\frac{3}{4}$ pounds. Attention to these teeth was followed by progressive and normal increase in weight.

Only two or three studies are available which fail to support the usual medical opinion that defective teeth are injurious to health. One of these was an investigation made by the school doctors of Magdeburg, Germany, in 1910–11, and reported by Dr. Henneberg (11). The procedure in the experiment consisted in selecting from each schoolroom five poorly nourished and five well nourished children and subjecting them to dental examination, to measurement of height, weight, and chest girth, and to year-long observation for contagious disease. On the basis of his own 150 cases Henneberg denies any significant relationship among the traits in question and states that the other 22 school doctors were led to the same conclusion.

For two reasons, however, the conclusions of the Magdeburg school doctors do not seem warranted by the data of the investigation. In the first place, they ruled out of the investigation (1) all children from the poorest homes; (2) all of tubercular heredity; (3) all vacation colony children (the pre-tuberculous); and (4) those subject to frequent illness. These four classes are, of course, just the ones in whom the extreme influences of defective teeth are most likely to be detected.

In the second place, their data do show certain significant differences. Of the badly nourished, 61 per cent had "bad" teeth (four carious teeth, or more); of the well nourished, only 52 per cent. Bad teeth were therefore more than one sixth less frequent with the well nourished. During the year children with good teeth gained an average 5 per cent more in weight and 10 per cent more in height than those with bad teeth. On selecting the 22 children having the very worst teeth and comparing them with the 22 having the very best, the following important differences were found: —

TABLE 23

	Poorly nourished	Well nourished
With worst teeth (22)	9	13
With best teeth (22)	14	8

Of the children 38 were suffering from marked anæmia, and of these 28 had "bad" teeth and only 10 had "good" teeth. The actual correlation is too obvious to require further comment.

Dr. Henneberg's conclusion, denying any relationship, seems to rest on the erroneous premise that if such a correlation existed it would hold for every individual case, and that the child with poor teeth would *always* be found inferior in nutrition, height, weight, blood composition, susceptibility to contagious disease, etc. Such, however, would be the case only if bad teeth were the sole cause of the defective conditions named. This, of course, is maintained by no one. In reality the data should be interpreted as supporting, rather than discrediting, the conclusions which have resulted from clinical evidence against defective teeth.

On the other hand, we must avoid attributing to defective teeth conditions which are due to other causes. Thiele's examinations of 1500 children entering school in Chemnitz (Germany) showed that children classed as having "unsatisfactory" teeth (four or more defective) did not differ materially from those having "satisfactory" teeth (less than four defective) as regards nutrition, rickets, tuberculosis, adenoids, heart defects, discharging ear, or speech defects (30).

Dr. Ernst's study of the dental conditions of 500 boys entering school in Kiel (Germany) also gave little correlation between the condition of health and the number of carious teeth except when the latter numbered nine or more. Ernst agrees with Henneberg that in such cases the decayed teeth are less the cause than the result of low general vitality (7).

A complete reinvestigation of the problem is urgently needed. In further studies of this type, the classification of pupils according to dental defectiveness should be made on a finer scale. Classification into two groups only, those with "good" teeth and those with "bad," is needlessly coarse for statistical purposes.

The cause of dental caries

The salient facts of dental caries have been succinctly stated by Pedley and Harrison (23, pp. 75–76) as follows: —

1. Dental caries always commences on the outside, and is due to external causes.

2. Fermentation and putrefaction of particles of food are effected by the ever-present bacteria, and this involves the production of acids.

3. The enamel is attacked at one spot, some places being more vulnerable than others, especially in crevices where food has the opportunity of resting.

4. The enamel prisms are split up and disintegrated. When the dentine is reached, the acid-forming bacteria dissolve out the lime and leave a softened area.

5. The dentinal tubules are invaded, and they become swollen and dilated.

6. Liquefying bacteria dissolve the tubes and the gelatinous matrix.

7. Further disintegration of enamel, with dissolution of the dentine, leads to the formation of a cavity, in which food and bacteria find a resting-place.

8. Gradually the pulp is infected.

9. Owing to inflammatory action, the nerve tissue is irritated, the blood pressure is increased, and the vessels become dilated.

10. Pus appears in isolated spots, and the whole tissue dies.

11. This is followed by decomposition and putrefaction.

12. When this septic material is forced through the root an abscess (gum boil) is the result, accompanied with fever and general malaise.

The mouth is an ideal culture medium for germ life because of the warmth, moisture, and nutritive material afforded. Streptococcus and staphylococcus, both pus producers, are always in the mouth. Pneumococcus (the germ causing pneumonia) and the tubercle bacillus are frequently found. On the basis of partial counts it has been estimated that a moderately unclean mouth may harbor more than a billion bacteria.

The enamel and dentine are not broken down by the bacteria directly, but by the acids produced by the action of bacteria upon the food particles left in the mouth. The problem, therefore, is the prevention of acids. The saliva, which is slightly alkaline, helps to do this. In ill-health, however, the saliva may lose part or all of its neutralizing power; and what is still more important, food remnants that are left thickly plastered in the recesses of the teeth protect a part of the deposit from the effect of the saliva and so permit the destructive processes to begin. Recessive gums, mouth breathing, and accumulations of tartar have also this effect.

The rate of acid formation depends in part upon the nature of the food particles left in the mouth, the carbohydrates being the foods which most readily ferment and produce acids. For this reason a meal should not end with jams, jellies, cake, candy, or other foods rich either in starch or sugar, nor should these be eaten between meals. When sweets are eaten, they should be followed by solid foods, such as apples, which have a cleansing effect. The high susceptibility in this country to dental caries may be partly accounted for by the fact that our sugar consumption per capita is by far the highest in the world.[1]

[1] Merritt gives this as 92½ pounds per capita, or 15 pounds higher than our closest competition.

Whatever the food, the essential problem is that of keeping the mouth clean. The main obstacles to this are three: (1) dental irregularities; (2) the use of soft, sloppy, or pasty foods; and (3) insufficient mastication. Wallace (32) has convincingly shown that even, well-matched teeth clean themselves in the thorough mastication of solid foods, and that they do this more effectively even than the toothbrush. If the food is pasty, however, mastication plasters it so tightly against the teeth that no ordinary amount of brushing removes it. Wallace believes that the choice of solid food and its deliberate mastication are more important preventive measures than any amount of artificial cleanliness. His opinion is based on over 6000 experiments made for the purpose of determining differences in the tendency of different foods to lodge in the mouth.

In order to try the theory, Wallace secured parental coöperation in subjecting fourteen children to a test. From the age of three or four years they were given foods of high tooth-cleansing power and were required to masticate thoroughly. After each meal the mouth was rinsed. At the age of five to seven years not one of the children had a carious tooth.

When a tooth is sore, mastication is shifted to the other side of the mouth or else slighted altogether. The teeth consequently do not clean themselves, particularly on the involved side, and caries results. Moreover, as already pointed out, deficient mastication leads to maldevelopment of the jaws and resulting dental irregularities. This, in turn, adds another obstacle to thorough mastication and hinders the self-cleansing process. Decay once started tends to spread to adjacent teeth mainly for the reason that the soreness interferes with mastication on the involved side and the teeth of that side become clogged with food remnants.

It is largely for the above reasons that the care of the temporary teeth is so important. When neglected, as they usually are, thorough mastication is out of the question and the jaws do not properly develop. The palate tends to become arched, and the permanent teeth are almost sure to come in crowded or uneven. Wallace even believes that irregular teeth and arched palate are more the cause of adenoids than their result, and that if larger use were made of solid foods, if mastication were always thoroughly performed, and if the temporary teeth were carefully preserved, adenoids would rarely develop.

At any rate, irregularities of the teeth are known to be extremely productive of caries and should always be corrected. It is estimated that about 80 per cent of adults have one or more dental irregularities predisposing them to caries. Pits and crevices in the teeth, however caused, act as lodging-points for food, are difficult to cleanse, and are therefore always the starting-points for decay.

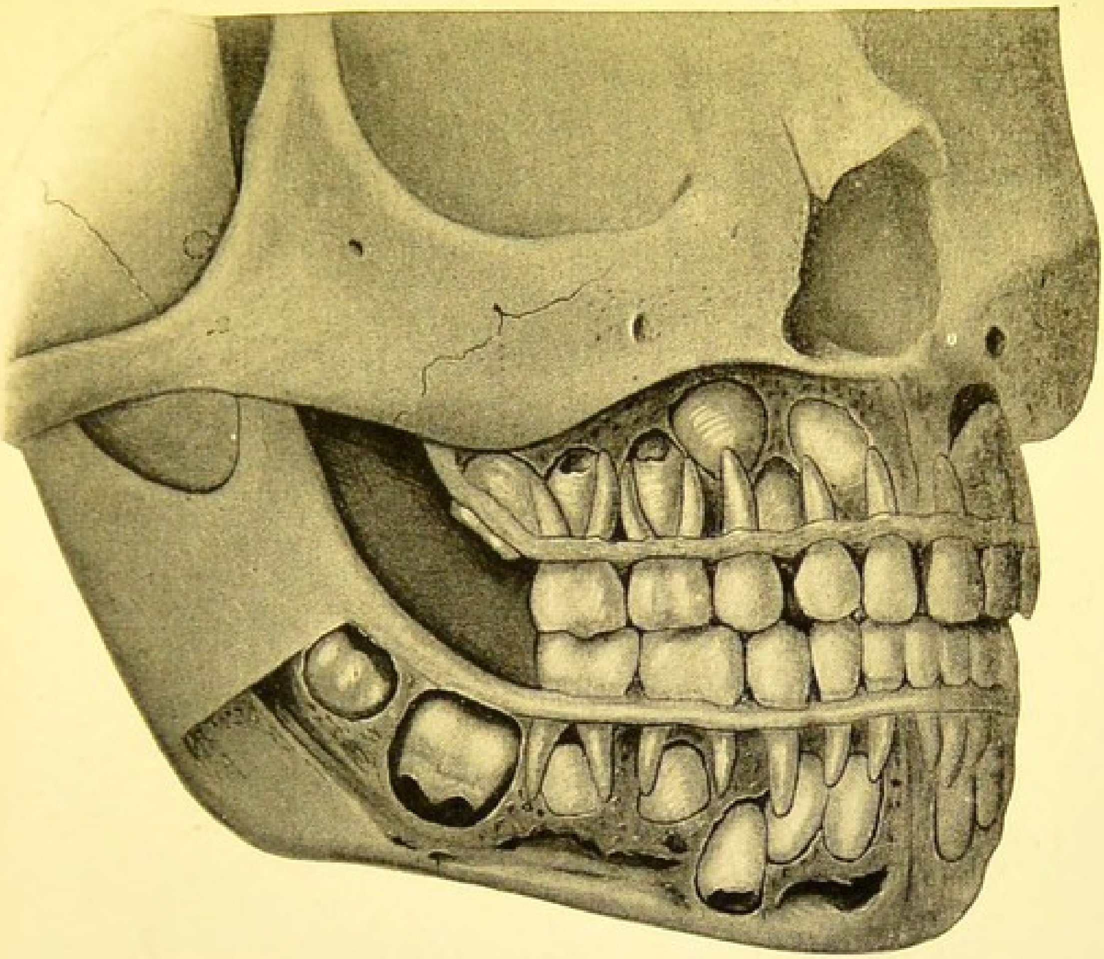
Thus far we have considered the immediate cause, the presence in the mouth of acid-forming bacteria. Another factor of great importance is the tooth's power of defense. If the enamel is thin or defective in structure, disintegration is made easy. It is well known that individuals differ enormously in their natural resistance to dental caries. Some teeth remain perfectly sound without the slightest care; others require all the arts of dentistry to hold them together. We must consider, therefore, the tooth's nutrition.

Both sets of teeth are formed and embedded in the jaw long before the end of pre-natal life. When the milk teeth are beginning to appear, the enamel of the permanent teeth is already developing. As far as is known, enamel once formed changes little for better or for worse from natural causes. We must go through life with our original dental armaments. There is no second dispensation.[1] When nutrition is insufficient during infancy and childhood, the teeth are very likely to be imperfect. Growing cells cannot build a perfect structure without suitable material.

The main cause of infantile malnutrition is artificial feeding. Michael[2] investigated the relation of dental caries to infant feeding in 11,762 children. Those who had been suckled ten months or more had only 9 per cent of their teeth carious; those fed on cow's milk, 22 per cent; those whose principal diet was oatmeal water, 27 per cent. Children suckled six months had teeth correspondingly inferior to those suckled ten months. Rose's study of 157,000 children shows the same thing. Even the mother's milk is sometimes inferior, due to

[1] While this is certainly true in the main, some authorities make allowance for the possibility of slight physiological changes in the enamel after the tooth has attained its growth.

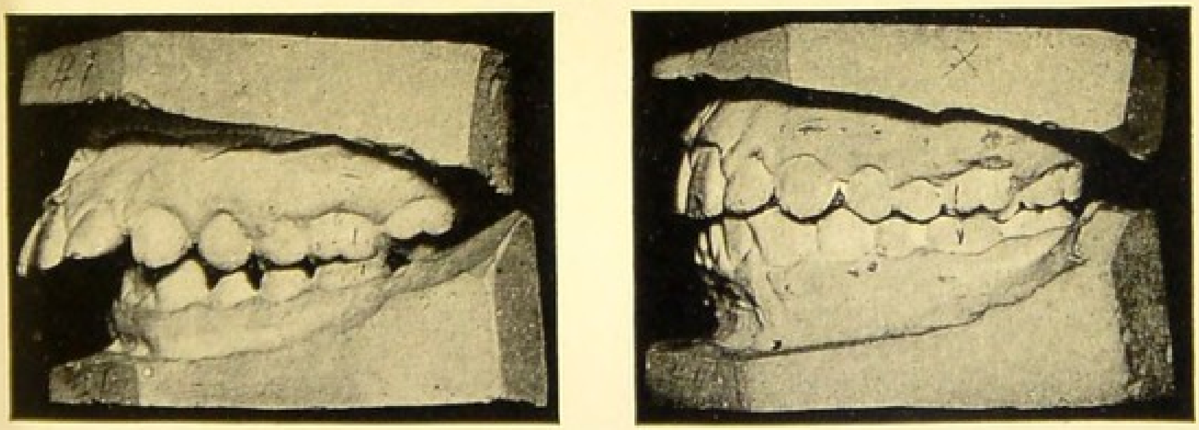
[2] Quoted by Colyer.



THE REPLACING OF THE TEMPORARY TEETH

Showing the rudimentary permanent teeth embedded below the roots of the temporary teeth

From *A Handbook of Health*, by Woods Hutchinson, M.D. Houghton Mifflin Company, publishers



BEFORE AND AFTER

Plaster of Paris casts showing results of orthodontia

(Courtesy of Dr. C. S. McCowen, Palo Alto, Cal.)

worry, overwork, alcoholism, specific disease, etc. Jewish children, who as a rule are breast-fed and otherwise well cared for, are much less subject to dental caries than other children (23).

The following table from Ernst (7) shows the striking correlation between the number of carious teeth in children entering school and infant malnutrition: —

TABLE 24

	Rickets	Bottle children	Breast-fed 3 to 6 mos.	Breast-fed 6 to 9 mos.	Breast-fed 9 to 12 mos.	Breast-fed 12 mos.+
Number of carious teeth...........	8.25	6.25	4.8	4.	3.3	3.
Per cent of children with perfect teeth	0.	1.14%	6.63%	16.%	16.4%	21.3%
Distribution of those with nine or more carious teeth...........		64. %	22. %	22.%	14. %	14. %

Since the enamel of the permanent teeth is in process of formation throughout the early years of childhood, temporary disturbances of nutrition, such as measles, scarlet fever, etc., often leave horizontal rings of microscopic pits around the enamel.

Rose finds a correlation between the prevalence of dental caries and lime deficiency in the soil. In regions with least lime, caries was present with from 98 to 98.7 per cent of the children; where the proportion of lime was greatest, the number affected ran as low as 79 to 82.8 per cent (27).

Rose and Underwood have demonstrated the closest relation between dental caries and the degree of civilization. All primitive races are practically immune, regardless of food habits and of habitat. Native Africans are practically immune, also Eskimos. The former clean their teeth religiously after each meal, the Eskimos never. Natives of India, Malays, and Australians are also little affected.

It has not been demonstrated, however, that the difference is one of racial heredity. From an examination of many skulls, Underwood shows that dental caries is ten times as prevalent in western Europe to-day as it was one hundred years ago. European skulls of the eighteenth century average about one decayed tooth each; those of to-day about ten. Smith (31) examined over 50,000 Egyptian skulls and found practical immunity up as far as 4000 B.C.; after that a rapid increase. Of 500 "aristocratic" skulls dating from the pyramid epoch, only 50 were free.

It hardly seems possible that actual racial degeneracy as regards the power of the teeth to resist decay could establish itself so universally in a few generations. Nor is it necessary to assume such degeneration. Underwood, who has made the most extensive researches in this field, holds that the facts are readily explained in terms of changed food habits. Cooked, mushy, and sticky foods have replaced foods that were resistant and fibrous. The consumption of sweets has been multiplied many times. Mastication can more easily be slighted. This tends to produce irregularities of the teeth and maldevelopment of the jaws. Babies are less often nourished in the natural way, and all through childhood there is a deficiency of the sunlight, air, and activity necessary to healthy growth. The disease is a disease of civilization.

For these and other reasons, the prevention of dental caries is becoming a more difficult problem than ever before. If the disease is not arrested, micro-organisms will soon score their first complete victory.

Prevention

Appropriate preventive treatment during childhood would probably insure good teeth to a majority of adults. Preventive measures should include especially cleanliness, thorough mastication, suitable food, the care of the temporary teeth, nutrition during infancy and childhood, the prevention of decay, the prevention of irregularity, and the repair of defects as rapidly as they appear. To this end the school can make two contributions of the greatest importance: (*a*) It can instruct children more thoroughly than it now does in the essentials of mouth hygiene; and (*b*) it can undertake preventive and curative treatment in school dental clinics.

(*a*) *The teaching of mouth hygiene.* The common practice among authors of textbooks in physiology and hygiene, of dismissing the subject of teeth with a page or two, touching mostly on their anatomy, is indefensible. Instead of such summary treatment the whole subject should be thoroughly canvassed. The brief presentation of a few essential facts relating to their anatomy should be followed by a fuller discussion of the importance of good teeth for health, the causes of dental decay, and the means of its prevention. The instruction should be extended over several years, and liberal use should be made of plates, wall charts, and illustrative material. Health rules for the teeth could well be pasted in the backs of all schoolbooks.

Special effort must be centered on making the instruction carry over into action. Health instruction without health habits is vain. Children should be taught in the school how to rinse the mouth, to gargle, and to brush the teeth. Actual drills for this purpose are to be commended. The sentiment of disgust may be advantageously enlisted in the interest of mouth cleanliness.

Factors which influence the growth and decay of the teeth in infancy cannot, of course, be reached directly by the school. They may be reached indirectly, however, by the education of girls and young women for the duties of motherhood.

(*b*) *The school dental clinic.* The school should offer treatment as well as instruction. The universal prevalence of dental caries has been sufficiently shown; likewise that it is folly to expect the parents of to-day to deal adequately with the problem on their own initiative. Parents, unfortunately, are too likely to be satisfied as long as the tooth does not ache. It is an exceptional father who knows what the lips of his children conceal. Thousands of them have never essayed a glance into the interior of the mouth they work so devotedly to feed. In the most aristocratic suburb of

Boston 75 per cent of the children had never been to a dentist. Not over 5 per cent of the children in the United States regularly receive the dental treatment they need. Even physicians are likely to neglect their opportunities to give advice about the care of the teeth.

The six-year molars are especially subject to decay and are usually mistaken by parents for temporary teeth. Consequently they are usually neglected till the day of salvage has gone by. Dr. Mary Gallup, of Boston, examined the mouths of 3000 adult Americans and found only 7 complete sets of six-year molars. Dr. Henie, of Norway, found over 40 per cent of the six-year molars diseased by the end of the eighth year and 60 per cent by the end of the fifteenth year.[1]

In fact, there is no other matter of health where the proverbial ounce of prevention will go so far. Dental caries is a disease of childhood and youth. "The person whose teeth are neglected till the age of twenty is already a lost cause." "When a tooth has ached, the best time for saving it has gone by." To preserve in a sound condition the teeth of an entire family costs no more than the belated treatment of a single tooth. To insure the necessary treatment no other means is as cheap or effective as the school clinic.[2]

Finally, orthodontia[3] should be encouraged. There is no reason why the child's health should be jeopard-

[1] Quoted by Burnham.

[2] For a discussion of school dental clinics see *Health Work in the Schools*, by Hoag and Terman. Houghton Mifflin Co.

[3] The mechanical treatment of dental irregularities and deformities of the jaw.

ized and his face made repulsive just because his parents lack the knowledge or the money to remedy the defect. Nothing in the way of dental irregularity is bad enough to be hopeless if taken in hand early enough. A little girl known to the writer had at the age of ten years the facial appearance of an idiot. The palate was arched high and pointed at the front like the letter V. The upper teeth, already projected beyond the lips, were so crowded that one appeared entirely within the V. The child suffered constantly from indigestion and headaches. Four years of orthodontia transformed the repulsive face into one of absolutely normal appearance and brought every tooth to its proper position. The anæmia and headaches disappeared simultaneously. The plate facing page 188 illustrates the miracles that are constantly being wrought by orthodontia.

Some indications of dental defects

Unclean-looking teeth.
Unsound-looking teeth.
Unhealthy-looking gums.
"Gum boils."
Crooked teeth.
Prominent teeth.
Offensive breath.
Toothache.
Admission of never having been treated by a dentist.
Neglect of daily use of toothbrush.
Headache.
Enlarged lymph glands in the neck.

Indigestion.

General malnutrition.[1]

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CHAPTER XII

THE HYGIENE OF THE NOSE AND THROAT

Written with the assistance of Dr. E. B. Hoag

Relation of the nose and throat to health

THE hygiene of the nose and throat during childhood is important for several reasons. In the first place, the condition of the respiratory passages determines in large measure our susceptibility to many infectious diseases. It is now well established that diphtheria, scarlet fever, measles, mumps, whooping-cough, infantile paralysis, influenza, ordinary colds, pneumonia, and tuberculosis all gain entrance to the body in the majority of cases through the nose or throat passages. Not only is this true, but the secretions of these passages are capable of harboring for an extended period the organisms of many, if not all, of the diseases mentioned. In such cases the individual concerned may remain a "carrier" long after he himself has recovered. This fact has not yet been demonstrated for all of the above-named diseases, but it has been so completely and satisfactorily proved in respect to diphtheria, tuberculosis, pneumonia, and infantile paralysis that we are justified in the belief that it occurs also in others.

The nose and throat passages are provided by nature with certain safeguards against the invasion of disease germs. These include the tonsils (the pharyngeal tonsil or normal adenoid structure of the back part of the nose, and the lingual tonsil on the back of the tongue), the mucous secretions, the ciliated cells of the epithelium of the nose and bronchial tubes, and the hairs lining the outer portion of the nasal passages. Anything that interferes with the health of these passages renders the body more liable to infection. Consequently, adenoids (overgrowth of the third tonsil), enlarged inflamed tonsils, small follicular tonsils, nasal catarrh, or obstruction of the nasal passages by means of polypi or enlarged turbinates, all tend to break down the natural barriers against disease germs. Children with adenoids or diseased tonsils nearly always suffer from a greater number of children's diseases than do others, and it has been observed time and again that such children have an increased tendency to tuberculosis, either general or lymphatic (i.e., of the lymph glands of the neck). The occurrence of cervical adenitis, or inflammation of the neck glands of a non-tubercular character, is frequently observed in connection with adenoids or diseased tonsils by every medical officer of schools.

Tonsils in a state of health serve as guardians against infection, but diseased tonsils not only lose their power to protect the body, but actually harbor disease germs and their poisonous products. These facts ought to answer, once for all, the question as to the advisability of removing diseased tonsils or adenoids.

While it is well known that inflammation of the tonsils (tonsillitis) produces fever and general disability, it is not so generally understood that both the throat tonsils and the third tonsil, or adenoids, may be diseased without the knowledge of the patient and produce fever and general malaise. This is particularly true of adenoids, which are often infected. In such cases the cause of the fever and consequent sickness is often regarded as obscure, and sometimes the real cause is not discovered at all. The intimate relation of diseased tonsils and adenoids to the general health of the body is most important, while the special relation of these structures to acute infections, catarrh, and deafness is so important as to demand the utmost care.

In the second place, obstruction of the nasal passages forces the individual to "mouth-breathing." Why should it be a matter of concern whether one uses the mouth or the nose for a breathing-passage? The answer is that the nose is much more than a mere tube for breathing. It performs at least five important functions which the mouth can perform only partially or not at all.

(1) The nose acts as a marvelously effective filter, clearing the inspired air of nearly all its dust particles and germs. This is accomplished chiefly by the ciliary projections of the mucous linings, which intercept nearly all the small foreign bodies of the air and carry them, by means of constant wave motions, to the pharynx and mouth, there to be expelled. If the mucous membranes are too dry, or if their secretions are not normal, as in catarrh, this function of the nose is seri-

ously interfered with. In case of mouth-breathing the filtering takes place to only a slight degree.

(2) Due to the shelf-like arrangement of the turbinated bones, the walls of the nasal passages contain an extensive surface of mucous membrane. This is supplied with a vast system of blood vessels which permit the heating of the air in its passage to the lungs. The blood sinuses are surrounded by involuntary, erectile muscular fibers which work automatically so as to regulate the amount of blood in the vessels near the surface. When we go out into a cold atmosphere the amount of blood in these vessels is quickly increased to permit the more rapid warming of the air.

(3) The arrangement just described also makes possible the addition to inspired air of a great deal of moisture. Air which is received at 20 to 40 degrees temperature, and which contains but little moisture, is raised almost to body heat and becomes two thirds saturated in its passage through a healthy nose. The significance of this for health lies in the fact that the interchange of gases in the lungs is largely dependent upon the temperature and humidity of the air in the lung cells. It is estimated that the healthy nose adds to the inspired air about one pint of water every twenty-four hours.

(4) The nose is an important organ of phonation. When it is obstructed by adenoids, enlarged tonsils, or polypi, the resonant chamber is reduced in size, giving the thick quality of speech known as the "nasal voice." This is due chiefly to the interference caused by nasal

obstructions in the formation of overtones. The learning of a modern language is made more difficult, and in extreme cases certain sounds cannot be produced at all.[1]

(5) Mouth-breathing eliminates the sense of smell. This sense may have less importance than it once had, but is still far from valueless. It not only acts as a warning against dangerous gases and impure air, but has also an æsthetic value, as Helen Keller has beautifully shown us.[2]

The hygiene of the nose is important for several other reasons. More than half the cases of deafness, and most cases of partial deafness, are caused by obstructed breathing. There are probably one million children in the schools of the United States who are hard of hearing from this cause. Earache and ear-discharge are nearly always due to infection which has spread from an unhealthy nose or throat to the middle ear through the eustachian tube.[3] Diseased air passages also befoul the air of the schoolroom and add to the difficulties of school sanitation.

Finally, and most important of all, mouth-breathing lowers mental efficiency, causing apathy, dullness, nervous instability, etc., with consequent school retardation. That form of inattention resulting from nasal obstruction has been given the special name "aprosexia nasalis."

In a valuable study Kafemann tested the mental

[1] See p. 200.

[2] Helen Keller, *The World I Live In*. (Chap. entitled "Smell, the Fallen Angel.")

[3] See p. 228 *ff*.

efficiency of two groups of normal subjects.[1] Those of one group had the nostrils artificially closed during the test; those of the other group were permitted normal respiration. The results proved that artificial stoppages of the nasal passages for even a few hours lowered mental efficiency.

Enlarged tonsils

The faucal tonsils are the ones which are ordinarily spoken of as "the tonsils," and are situated at either side of the root of the tongue. Normal tonsils are barely visible, but enlarged tonsils range from the size of an almond to that of a large English walnut. It is not difficult to see the tonsils if the child will open his mouth wide, relax his throat, and take a deep breath, or better, pant. A wooden tongue depressor may be used to hold down the tongue, but this is not always necessary in routine examination after a little skill has been acquired in the management of the child.

The normal tonsils appear as small, oval, smooth, pinkish masses of lymphoid tissue. Any marked overgrowth, holes (crypts), redness, white spots, or irregularity in structure indicate abnormal conditions. Overgrowth of tonsils in young children is extremely common, and may occur without any other sign of disease. In fact, this condition is so common that unless it is a fairly severe case many physicians consider it best to disregard it.

Like the lymphoid structures of the neck, the tonsils

[1] The "addition test" was used.

are often somewhat enlarged without causing any noticeable symptoms. The tendency to a small amount of glandular enlargement, though not normal, must not be unduly emphasized. In many cases such conditions tend to disappear spontaneously as the child grows older and stronger. On the other hand, it should not be forgotten that marked glandular enlargement indicates what is called a "lymphatic diathesis," which is a serious condition. The presence of a chronic inflammation always undermines the health more or less. Good judgment and experience are required in estimating the importance of enlarged tonsils, and there is probably no other point in the physical examination of children on which examiners so greatly disagree.

Enlarged tonsils are often the index of other bad conditions. Many children with enlarged tonsils present also such symptoms as pallor, anæmia, malnutrition, and enlargement of the cervical (neck) glands. In these cases all the lymphoid tissues of the throat and neck are likely to be infected, the child's resistance to disease is low, and the entire physical organization needs building up.

The structures most often affected in children are the faucal (throat) tonsils and the post-nasal tonsil, or adenoids. Adenoids are only the result of overgrowth of the third tonsil, and do not represent a new growth in any sense. The faucal and the nasal tonsils are structurally similar, being made up of lymphoid tissue. Like all other lymphoid tissues, they are much disposed to hypertrophy (enlargement) during childhood.

The function of the three tonsils is not fully known, but it is believed that when healthy they arrest the entrance of disease germs into the lymphatic vessels and blood stream. Diseased tonsils, on the other hand, are thought to act as points of entrance for various kinds of infection. It is believed by some of the best authorities that rheumatism frequently, if not usually, invades the body by this route. At any rate, a previous history of tonsillitis is often discovered in cases of articular rheumatism. As shown elsewhere (p. 310), chorea and heart disease often follow an attack of acute rheumatism. Tonsillitis, acute rheumatism, chorea, and heart disease are coming to be regarded as a quartet of one family.

Whatever may be the useful functions of the tonsils, including the third tonsil, when in a state of health, there can be no question that after they become diseased, they are of no use and are often positively harmful to the body.

Diseased tonsils are often associated with defects of the nose. The explanation is simple when we consider that the nasal and throat passages are continuous, and that their anatomical structure is very similar. The throat, nose, eustachian tube, and middle ear are lined by one and the same membrane. Disease of any part of this membrane tends to spread to all of it. The intimate structural relations of these parts are shown in Fig. 16.

Tonsils may be enlarged without any apparent inflammation, and, as already explained, this condition is not always to be regarded as especially serious. Whether overgrown tonsils should or should not be removed will depend (*a*) upon the degree of enlargement, and (*b*) upon the cause of enlargement. In most cases only a physician of experience can render an intelligent judgment. Simple enlargement may be only a part of a general lymphatic disturbance, and may in some cases have existed from birth. If the tonsils are so large as to interfere with breathing, they should certainly be removed. One frequently sees tonsils of this character so large as to meet in the middle line of the throat.

Tonsils may be enlarged because of acute or chronic infection causing inflammation. In every case of acute tonsillitis there is some such enlargement, which, however, may not require any surgical treatment. On the other hand, small tonsils are often diseased and capable of producing acute tonsillitis. In such instances they practically always require removal.

Tonsils which are chronically enlarged because of inflammation should always be removed. Such tonsils often have crypts, or holes, containing cheesy material, and tonsils of this character are not only offensive but constantly septic. The products of inflammation fill the crypts, and poisonous materials are continually being absorbed into the system. Cryptic tonsils, whether large or small, are rarely treated with any success by other means than total removal. In a word, tonsils which are so large as to form an obstruction to breathing, and those chronically inflamed, whether large or small, should be completely removed. Successive attacks of tonsillitis from any cause usually indicate the necessity of surgical interference.

Ordinarily this can be properly done only by a nose and throat specialist. Many operations on tonsils are done by unskillful operators with results which are disappointing. If the tonsils are not completely removed they are likely in time to become enlarged again. Tonsils completely removed do not return. Much of the irregularity seen in tonsils is due to shrinkage following chronic inflammation or incomplete removal.

The proportion of school children who suffer from enlarged or otherwise diseased tonsils is fairly constant. There are some local differences, but the average is about the same for the whole school population. Dr. Hoag has found that in California, for some unexplainable reason, the proportion of diseased tonsils is considerably larger than in Minnesota. In general it is safe to say that about one eighth of our school children suffer from this defect. The proportion is considerably larger for children under ten years of age than it is for those older, and for children of the poor than for those of the more fortunate classes.

The effects of diseased tonsils are well classified by Cornell as follows: —

(1) Obstruction of respiration (usually not great);
(2) Increased liability to throat infections;
(3) Increased liability to heart infections and chorea;
(4) Increased liability to tuberculosis;

(5) Inflammation of the cervical glands;
(6) Lowered general vitality;
(7) Ear involvement.

No child with chronically diseased tonsils can possibly be well. Furthermore, he is constantly in danger of attacks of tonsillitis, diphtheria, scarlet fever, or rheumatism, and he is rendered abnormally susceptible to tuberculosis. His general vitality is almost always lowered and his mental processes may be retarded. No one should ever hesitate about the question of removing diseased tonsils from the throats of children. The operation is safe in the hands of a skillful physician, and enormously increases the child's possibilities of health, happiness, and efficiency.

Adenoids

Adenoids, as already stated, consist of lymphoid tissue forming a third tonsil and are situated behind the soft palate in what is called the naso-pharynx. It is a perfectly normal structure until it becomes overgrown or infected.[1] Adenoids more or less completely close the passage between the nose and throat and in this way produce the condition known as "mouth-breathing."

The adenoid child breathes with the mouth open because it is impossible for him to breathe in any other way. He usually sleeps with his mouth open and commonly snores. The obstruction from which he suffers is rendered much worse by taking cold, for the reason

[1] Most overgrown adenoids are infected.

that adenoids consist of a soft spongy mass of tissue which is always congested (full of blood), and which becomes much more congested when the child has a cold.

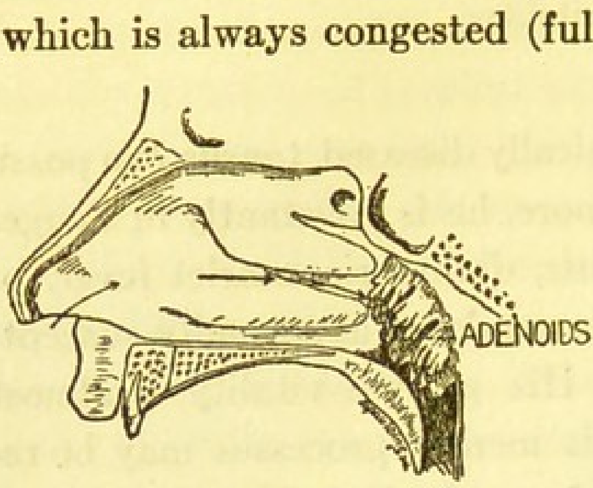


FIG. 15
A passage blocked by adenoids

Adenoids are sometimes found in infants at birth or soon after, but are more likely to be observed between the ages of 3 and 10 years. After puberty (12 to 16 years) they tend to disappear and are seldom found in adults; but in those cases in which they have been allowed to "absorb" without surgical treatment, unfortunate results always persist as evidence of the neglect.

There are three reasons for the greater frequency of adenoids in the early years of school life. (1) The lymphatic functions play a much larger part in the child than in the adult, and the lymphatic are therefore more prone to overgrowth. (2) As adolescence approaches, the throat enlarges very rapidly, and markedly relieves the crowded condition. At the same time the adenoids themselves are reduced in size by shrinking and partial "absorption." (3) Many of the older children have had their nose and throat obstructions surgically removed.

The proportion affected does not seem to vary greatly in the different countries of Europe and America. Kafemann reports 7.8 per cent for boys and 10.6 per cent for girls. Laaser (9) estimates that 10 per cent of the children in the common schools of Germany have adenoids. Of 9031 children examined in Leipzig, 23.2 per cent were affected. The number reported by the medical examiners in Stockholm was 13.8 per cent in 1905, and 12 per cent in 1906. Another Swedish investigation, by Stangeberg, reports 16 per cent.

Yearsley, however, on the basis of an especially careful study of 2315 children, estimates that 37 per cent of the pupils in the elementary schools of London have adenoids (14). Yearsley's results show that of those who have adenoids, three fourths have also enlarged tonsils, and 10.8 per cent ear complications. Sex differences, if any exist, are not great.

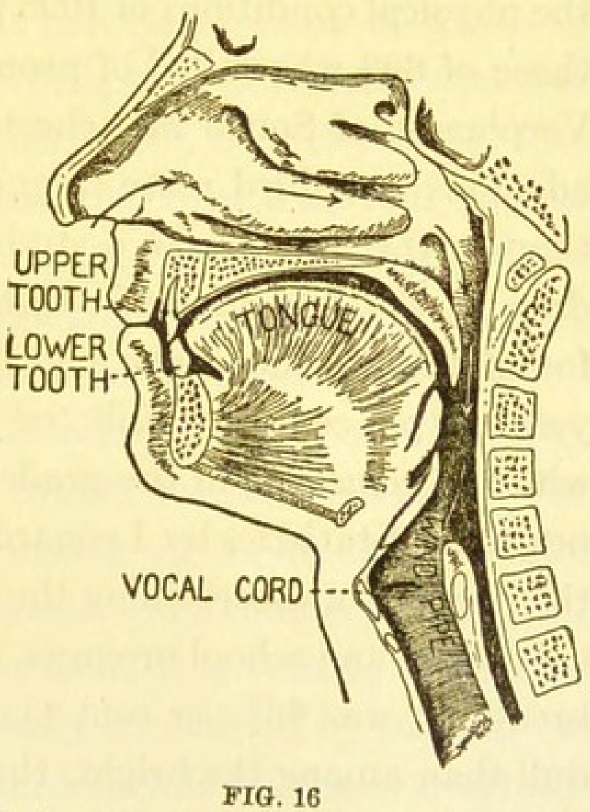


FIG. 16
A clear passage to the lungs. (Follow the arrows.)

The experience of Dr. Hoag, involving observations of more than 75,000 school children in widely different parts of the country, justifies placing the number at 8 per cent. More careful examination than is possible in routine school work would probably demonstrate a still larger proportion of adenoid children. In general, adenoids occur somewhat more frequently among poor and neglected children than among children of the better classes. This, however, is equally true of nearly all kinds of common physical defects.

Effect of adenoids

Retardation statistics show that defects of breathing are decidedly more common among retarded children than among those who are up to grade. Comparing the physical conditions of 1093 promoted children with those of 303 who failed of promotion, Superintendent Verplanck, of South Manchester, Connecticut, found adenoids one third more frequent in the latter group than in the former. In a study of 449 retarded children in the first grade in Elmira, New York, it was found that of those who had been in this grade two years 19 per cent were afflicted with adenoids; of those who had remained in the grade four years or more, 50 per cent. Statistics by Leonard P. Ayres, collected for the purpose of ascertaining the relation between physical defects and school progress, showed that obstructed breathing was $66\frac{2}{3}$ per cent more frequent among the dull than among the bright, the proportion among the bright, average, and dull being 9, 11, and 15 per cent, respectively. Compared with children having no defect, adenoid children showed a loss of 14 per cent in rate of school progress. Children with hypertrophied tonsils showed a loss of 9 per cent.[1]

1 These figures are based upon the data presented in chapter XI of Gulick and Ayres's *Medical Inspection of Schools*, 1913 edition.

Bonazzola (quoted in 5, p. 60), in an examination of 400 school children, found 141 who displayed symptoms of aprosexia. Examination of the 141 showed adenoids in all but 24 and some other form of nasal obstruction in all of the latter. Wilbert found, in a school composed of 375 boys, 26 who were described as bad scholars, and of these, 22 had adenoids.

If we can assume that 10 per cent of all our school children suffer from obstructed breathing, and if we can further assume that their instruction at school is only 90 per cent effective because of the dullness and ill-health produced by this defect, then the money loss from this source alone amounts to at least four million dollars annually. However, the financial aspect of the problem is much less important than the pedagogical, moral, and humanitarian considerations involved.

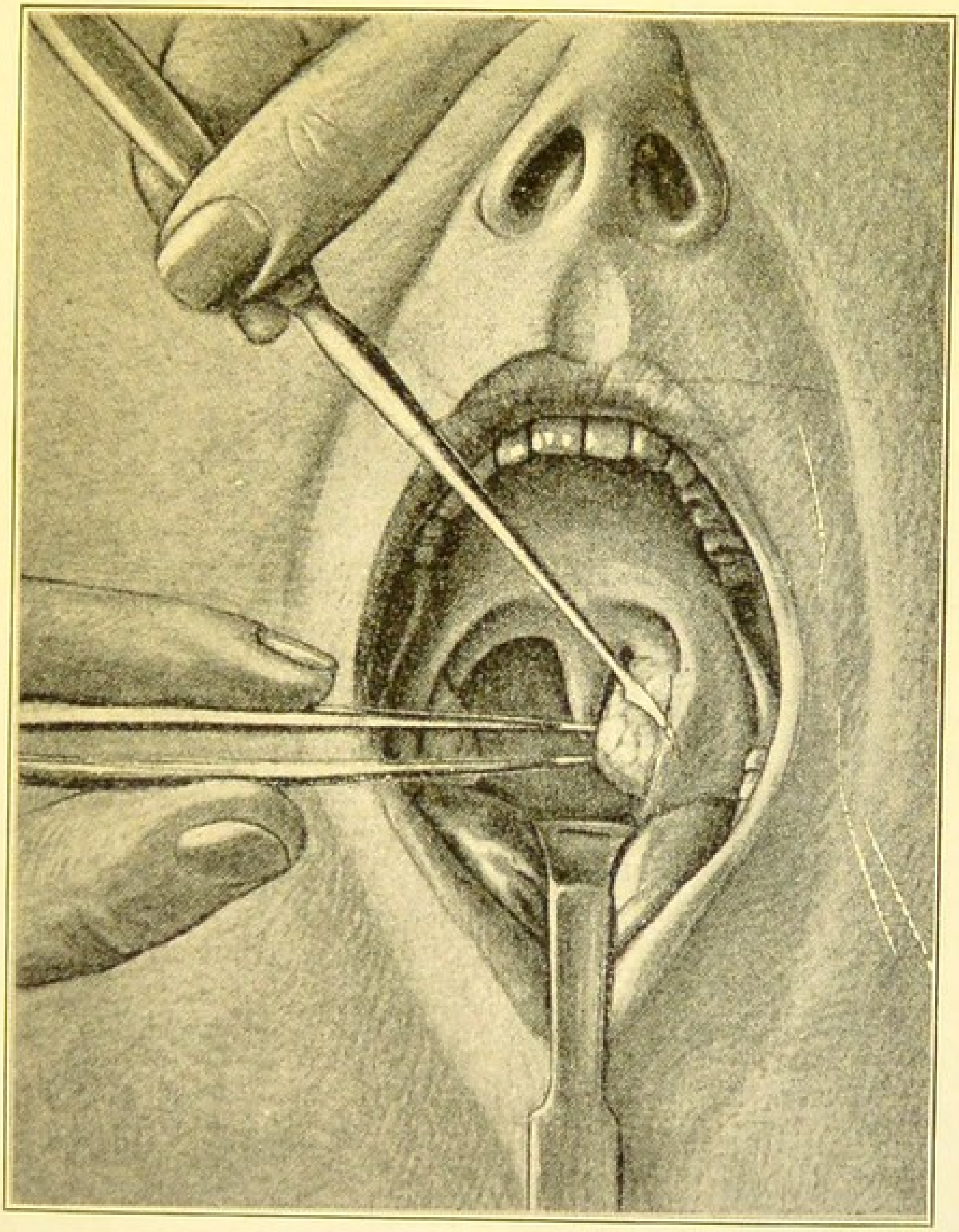
The teacher should nevertheless bear in mind that adenoids and enlarged tonsils are not responsible for all the dullness found among school children. While marked mental improvement often follows the surgical removal of nasal obstructions, it is vain to hope that stupidity can be universally eliminated by so simple a measure. The badly retarded child is usually mentally and physically subnormal by endowment, and often his physical defectiveness is only a symptom of the subnormality, not its true cause. There is danger that the influence of physical defects in causing retardation will be overemphasized: it is so much easier to remove adenoids than it is to ascertain the actual causes of retardation; so much easier to rely on surgery for its cure than to devise the needed reforms of educational administration and pedagogical procedure.

By questioning teachers, Cornell (2) investigated the mental effects of adenoid removal in the case of 63 children. Of these, 19 were said to have "improved much," 25 to have "improved," 16 to have remained unchanged, and 3 to have deteriorated. The records of subsequent promotions attained by these pupils were distinctly less favorable. Out of 97 opportunities for promotions in the months following the operations there were 61 failures.

Yearsley's valuable study of London children (14) shows that only in severe cases are adenoids accompanied by the so-called "adenoid face" or by extreme aprosexia (inability to attend). Yearsley defends the view, now growing in favor, that adenoids are not the sole cause of the abnormally high palate so commonly associated with them, but that the arched palate is to some extent the cause of the adenoids; likewise that the associated irregularity of the teeth is partly due to the abnormal palate and not merely to the presence of adenoids. At any rate, adenoids and arched, narrow palates are usually found together. Dr. N. H. Bullock's measurements of 300 adenoid and 300 normal children of the same age showed that the breadth of upper jaw in the adenoid children averaged .6 cm. below that of normal children.

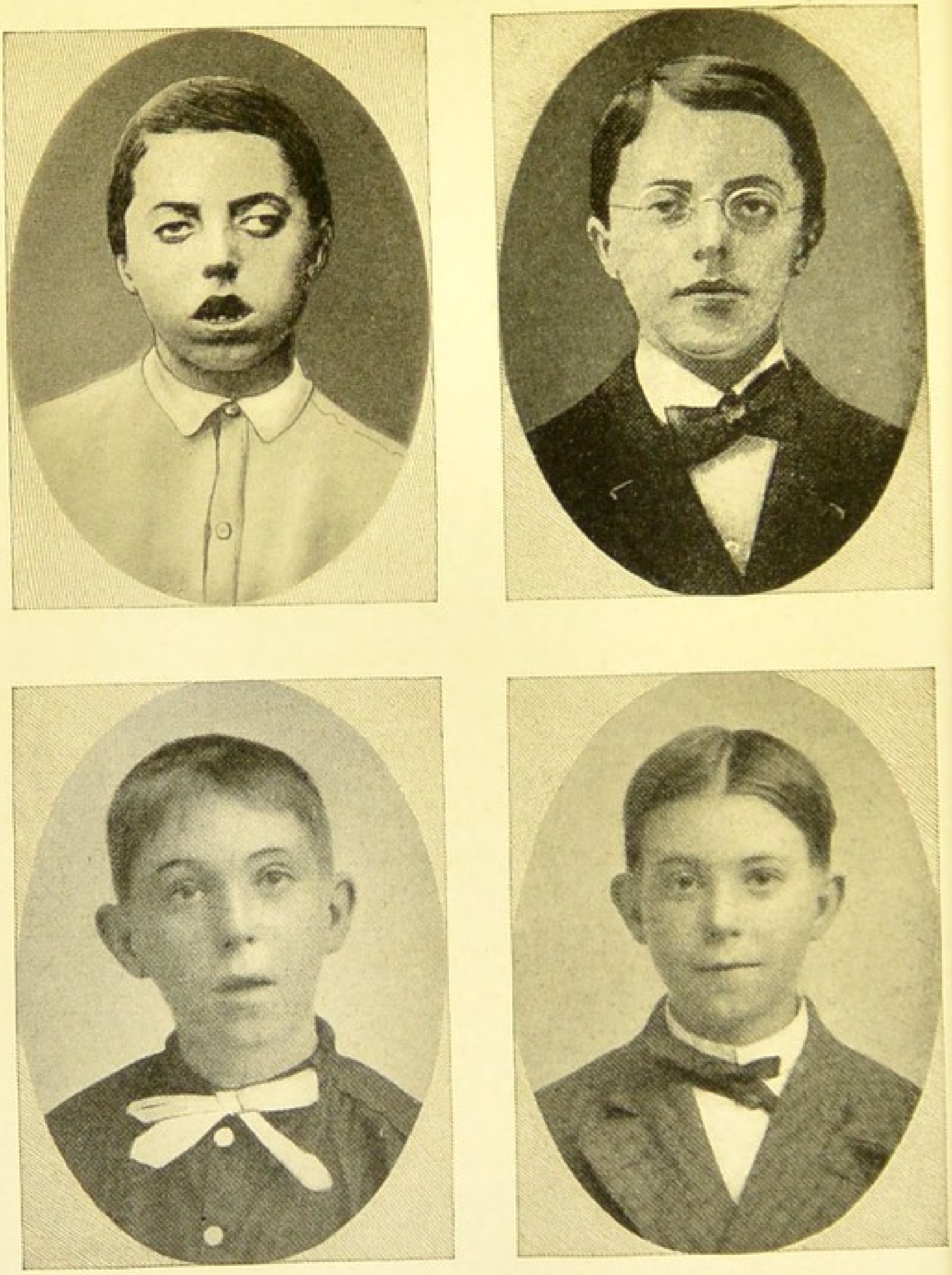
As shown in chapter XI, mouth-breathing and irregularities of the teeth predispose to dental caries.

Such mental effects as are produced by obstructed



THE PRIMARY INCISION FOR SEPARATING THE HYPERTROPHIED TONSIL FROM ITS ATTACHMENTS

From Phillips's *Diseases of the Ear, Nose and Throat.* By permission of The F. A. Davis Company, Philadelphia



BEFORE AND AFTER REMOVAL OF ADENOIDS

breathing have not been satisfactorily accounted for. One theory is that adenoids, particularly, interfere with the nutrition of the brain and with the removal of its waste products. This was the explanation offered by Guye, of Amsterdam, who first described the mental symptoms. It is more commonly believed that the aprosexia is due chiefly to chronic toxæmia (general poisoning) produced by the diseased lymphoid tissue, but in part, also, to the reduced depth of respiration and to lowered physical activity. Consideration of the hygienic functions of the nose would lead us to expect a gradual reduction of vitality when these functions cannot be performed.

Whatever may be the correct explanation for the frequent association of adenoids with certain physical and mental defects, it is well known that the adenoid child seldom develops normally. He is usually less active and less inclined to play. Kaster and Malherbe [1] found from measurements of 36 cases that growth in height, weight, and chest girth was, on the average, three times as rapid in the month immediately following the operation as in the month preceding.

Lung capacity and the shape of the thorax are nearly always affected by obstructed breathing. We are indebted to Dr. N. H. Bullock, medical examiner for the schools of San José, California, for valuable data on this point. Dr. Bullock compared the front-to-back and side-to-side diameters of the chests of 300 adenoid children with those of 300 normal children of the

[1] Quoted by Burnham.

same age. Of each group 200 were 14 years of age; the remaining 100 of each group, 7 years of age. In the case of the 14-year-olds, the side-to-side diameter of the chest averaged $1\frac{1}{2}$ inches below normal in the adenoid children, and the front-to-back diameter about 1 inch above normal. This gives the so-called "pigeon-breast" ("barrel-chest," "funnel-chest," etc.) so commonly found with adenoid children. In the case of the 7-year-olds, the breadth of chest averaged about one third inch below normal, and the depth of chest about one half inch above normal. Of the adenoid children, 6 per cent at 6 years and 16 per cent at 14 years had the "pigeon-breast," and practically all of the remainder a greater or less degree of "barrel-chest" or "funnel-chest." Among the non-adenoid children there was not a single marked case of these deformities. A comparison of the 6-year-old and the 14-year-old adenoid children shows that the deformity of thorax is much worse in the latter. The adenoids have had more time to do their injury.

As already stated, if the nasal passages are healthy throughout, the air which is breathed is rendered sterile before it reaches the lungs. This is true even when the number of organisms inhaled runs up into the thousands per hour. But if adenoids are present, a catarrhal inflammation takes place in the mucous linings of the nose. Three things result from this condition, all of them a menace to health: —

(1) The air is not properly humidified in its passage to the lungs;

(2) it is not sufficiently warmed before reaching the lungs; and

(3) it is imperfectly filtered of injurious bacteria.

Adenoids are also frequently the seat of tubercular infection. Pilet found 1 case tuberculous in 10; Brieger, 5 in 78; Goltstein, 3 in 33; Brindel, 8 in 64; Lewin, 10 in 200; Rethi, 6 in 100; Poliakov, 4 in 50, etc. (5, p. 66). Peters found tuberculosis in 45 per cent of 905 adenoids.

It is not necessary to exaggerate the evils of adenoids in order to place proper emphasis on the hygiene of nose and throat. There is no common type of defectiveness more serious as regards ultimate consequences for health than diseased conditions of the upper respiratory passages. The ultimate injury far exceeds the immediate. A given adenoid child may be able to keep out of the sick-bed and to make a fairly creditable showing in school, but may nevertheless fail on account of this defect to develop normal vitality. Many years after the close of school life, such a child is likely to prove an easy prey for infectious diseases and may pay the penalty of neglect by a premature death.

Causes of adenoids

Many explanations have been given to account for the presence of adenoids, no one of which is altogether satisfactory. Among the most common explanations are the following: —

(1) The "lymphatic constitution" (supposedly hereditary).

(2) Poor nutrition, and especially rickets and latent tuberculosis.

(3) Thumb-sucking and the use of the "pacifier."

(4) General unhygienic conditions of life, such as injurious dust, excessively dry and overheated atmosphere, etc.

(5) Infectious diseases of childhood, especially neglect of colds, whooping-cough, etc.

(6) Deviation of the septum (partition between the nostrils) or the presence of other partial obstructions to nasal breathing.

The preventability of adenoids and diseased tonsils is a question which has received less consideration than it deserves. The fact that all of the causative factors above enumerated, except the first, are largely subject to control, suggests that appropriate preventive measures might accomplish a great deal. Even the heredity factor may be eliminated by the practice of eugenics, once the laws of transmission are better understood.

Suggestions for observation

The signs and symptoms of adenoids may be grouped as follows: —

Nasal voice and defects of articulation;
Mouth-breathing;
Catarrh of nose or throat;
Pronounced tendency to colds;
A heavy or stupid expression;
An unusual fullness of the eyes;
Slow mentality (often retardation);

Poor physical development (often deficiency in play life);
Earache;
Ear-discharge;
Deafness, or partial deafness;
Crooked or prominent upper teeth;
A high, arched roof of the mouth;
Snoring;
Disturbed sleep;
Loud breathing during the day;
Undeveloped facial bones;
Nervous instability, shown by peevishness, finical habits, etc.

Some but not all the indications just enumerated will always be found present with adenoids. The signs most important for teachers and parents to note are the following: —

Open mouth and snoring at night (often with restlessness);
Nasal, expressionless voice;
Mouth-breathing during the day;
Heavy facial expression;
Mental dullness or apathy;
High, arched palate;
Crooked, prominent upper teeth.

Other throat symptoms may be listed as follows: —

Complaints of sore-throat;
Frequent attacks of tonsillitis;
Thick voice;
Offensive breath;
Rheumatism (often associated with diseased tonsils).

Summary

(1) The germs of many serious infectious diseases make their way into the body by way of the nose and

throat. If the tissues of these passages are unhealthy the resistance to such diseases is reduced.

(2) Obstructions of the nose, causing mouth-breathing, interfere with the important processes of filtering, warming, and humidification of the inspired air in its passage to the lungs.

(3) A healthy nose and throat are necessary for normal speech and for effective instruction in modern language.

(4) Defects of nose and throat are responsible for a large majority of the cases of deafness and partial deafness.

(5) Chronic inability to breathe through the nose sometimes results in mental torpor, defective growth, dental caries, and general low vitality. The influence of adenoids in causing feeble-mindedness, however, has probably been exaggerated.

(6) The mechanism by which adenoids and enlarged tonsils produce their injurious effects is not sufficiently known.

(7) Tonsils which are badly enlarged, or which are subject to frequent inflammation (tonsillitis), nearly always require removal.

(8) Adenoids which are large enough to interfere in any degree with nasal breathing, or which show any tendency to cause inflammation of the eustachian tube or the middle ear, should always be removed.

(9) Removal should take place early, usually by the sixth year, and sometimes much earlier.

(10) The preventability of adenoids and diseased

tonsils is a question which has not been sufficiently investigated.

(11) Teachers should be thoroughly familiar with the common symptoms of nose and throat disorders and with their results. They should instruct children from the earliest grades in the importance of unobstructed nasal breathing.

(12) The number of school children in the United States suffering from obstructed breathing is at least two million. The educational and hygienic treatment of these unfortunates is a matter of great national concern.

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CHAPTER XIII

DEFECTS OF HEARING AND THE HYGIENE OF THE EAR

Written with the assistance of Dr. E. B. Hoag

The prevalence of defective hearing

Studies of defective hearing among school children have given extremely large differences as regards the proportion affected. Some investigators report as few as 1 per cent; others as many as 50 per cent. This wide range in the statistics does not indicate any corresponding range in the actual prevalence of the defect, but is due mainly to the lack of a uniform standard as to what constitutes "defective hearing" and to lack of uniformity in methods of testing.

It is only for sake of convenience that we are justified in rigidly classifying individuals as having either "defective hearing" or "normal hearing." The most careful tests show that there is no plain demarcation between the two classes. Normal hearing is simply that degree of auditory acuity found in the majority of individuals. This shades off gradually into subnormal hearing on the one hand, and into superior hearing on the other. The farther we get away from the average in either direction, the smaller the number of cases represented. Because of the influence of disease, the number of cases with defective hearing is much greater than the number with above-normal hearing.

With the above explanation, such differences as appear in the following statistics ought not to be misleading. A low figure means that only severe degrees of the defect have been reported; a high figure means that minor defects also have entered into the results.

TABLE 25

Investigator	Place	No. of Children	Per cent reported defective
Reichard	Riga	1055	22.27
Weil	Stuttgart	5905	31.22
Gellé	Paris	1400	20 to 25
Moure	Bordeaux	3588	17.15
Bezold	Munich	1918	25.8
Zhermunsky	St. Petersburg	3577	13 to 16
Cheattle	London	1000	50
Felix	France	1038	31
Laubi	Switzerland	2200	10.6
Smedley	Chicago	5760	23.
Newmayer	Philadelphia	3587 "exempt" 1418 "non-exempt"	1. 2.
Bryan	Camden, N. J.	8110 normal age 2020 retards	4. 6.
Medical examiners	New York City	266,426	.5
Medical examiners	Five East-End Schools of London	1006	7.2

The above results were secured by a great variety of methods and standards. The report covering the greatest number of children, and one of the least valuable, is that from New York. In that city, evidently, a pupil has to be practically deaf in order to be considered defective in hearing. Among the most careful tests yet made are those of McCallie in Philadelphia and Reik in Baltimore. McCallie tested 560 ears and found 14 per cent "slightly deaf" and 2 per cent "quite deaf." Reik reports 10 per cent of 440 children as having defective hearing.

We may safely conclude, therefore, that from 10 to 20 per cent of school children do not hear normally and that the hearing of from 2 to 5 per cent is very seriously impaired. Sex and age differences are very slight, practically non-existent.

The number of persons who are entirely deaf is usually given as about 700 per million. This would be about 60,000 in the United States. However, if the rate for Germany can be accepted for this country, our deaf must number not far from 75,000. About half of this is acquired; the rest hereditary.

The importance of normal hearing for mental development

Hearing ranks in importance with vision as an avenue for the acquisition of knowledge. In certain respects, deafness is more damaging to mental development than blindness. Although the blind child, uneducated, may grow up very ignorant, he seldom gives the impression of being mentally defective. The uneducated deaf child, on the other hand, nearly always appears stupid. So true is this that deafness was formerly believed to be always associated with disease or deficiency of the central nervous system. School children who hear poorly are always in danger of being mistaken by their teachers for dullards.

This is readily understood when we stop to consider the rôle of hearing in everyday life. Deprived of this sense, even in part, the child suffers inevitable handicaps. Language development is stunted because speech is imperfectly understood; and language is the main vehicle of mental progress. The earning power may be reduced 50 per cent. The social instincts may be starved or perverted because normal intercourse with other children is impossible. Partially deaf children are apt to be considered "queer." Deprived of the healthful and educative influence of coöperative play, such children often fail to develop normally either in body or character. Misunderstood and misjudged on every hand, they are likely to harbor silent resentment or to develop traits of irritability, stubbornness, and the like.

That serious defects of hearing tend to produce school retardation has been fully demonstrated. The proportion of partially deaf children in the schools of Camden, New Jersey, was found to be 50 per cent greater among the retarded than among those who were up to grade. Newmayer's study of 5005 Philadelphia children showed that the 3587 who were excused from final examinations on the basis of good work had defects of hearing only half as frequently as the 1418 non-exempt. Barr asked Glasgow teachers to pick out 70 "very bright" and 70 "very dull" children. Examination of these revealed that 4 of the former and 10 of the latter were defective in both ears, while 10 of the former and 15 of the latter were defective in one ear. Permewan had 203 pupils in Liverpool classified by their teachers as "bright," "average," or "dull," and found that the average distance for hearing a watch tick was 51 feet, 47 feet, and 31 feet for the three classes respectively. Of 20 pupils reported as "poorest" in a school of Paris, Gellé found only 4 with normal hearing. Zhermunsky, at St. Petersburg, found 24 per cent of the pupils with normal hearing were classed by their teachers as "poor" in school work, while the proportion of "poor" among those whose hearing was less than one third normal was 58 per cent. The percentage of partially deaf among 1000 London children was as follows: —

Worst mentality	34½ per cent
Poor mentality	27
Fair mentality	33½
Good mentality	31
Excellent mentality	22

The figures just quoted indicate that although partially deaf children are not always retarded, they are more likely to become so than children with normal hearing. Among the very dull, especially, the proportion of partially deaf is abnormally high. Likewise the proportion of retarded children among the very deaf is also extremely high. Thus Kobrak, testing 400 children of Breslau shortly after school entrance, discovered six whose hearing was less than one twentieth normal. Five of these were considered stupid by their teachers. Of 205 pupils of the Berlin Hilfsschulklassen (classes for the mentally defective), 20 per cent had less than one third normal hearing and 8 per cent less than one twentieth. Wanner found 12 out of 39 children in the

Munich Hilfsschulklassen with less than one twentieth normal hearing (quoted by Kobrak).

One reason for the correlation between deafness and retardation lies in the fact that a very large proportion of those with defective hearing are "adenoid children," and are for this reason mentally sluggish. But that the stupidity of the deaf is often apparent rather than real is shown by Kobrak's study of 677 children in the Hilfsschulklassen of Berlin. It was found that in these classes, where the pupils are given a large amount of individual attention and are instructed by teachers of special training, the partially deaf were making on an average better progress than those with normal hearing. The explanation is not that deafness is an advantage, but that many of these children in the classes for mentally defectives were there because they could not hear well and not because of defective mentality.

The hearing of the deaf child is by no means uniform, but varies according to the condition of the weather, the state of the throat, etc. On some days it is almost normal; at other times extremely poor. This results in what appears to be an unevenness of attention and response; hence the child is likely to be scolded or otherwise unjustly treated.

Another result of defective hearing is overstrain of attention and mental fatigue. In order to realize how serious this may be, one has only to recall the feelings of strain and exhaustion experienced after an hour or two spent in listening to a public speaker whose voice was hardly audible.

Discharging ears

The discharging ear presents a very serious condition. If it is not treated until cured, the result is very likely to be either partial or total deafness. In many cases the infection spreads to the surrounding bone and necessitates a dangerous surgical operation. Sometimes death results. To have chronic discharge of the ear is like living over a powder mine. The explosion may not come, but there is always a dangerous possibility. Life-insurance companies reject applicants with chronic ear-discharge. Death from this cause often results in middle life, or after, and in such cases the condition usually dates back to childhood.

Severe defects of hearing are due to neglected inflammation of the middle ear oftener than to anything else. The condition is one which requires long-continued treatment. Skillfully treated, discharging ear is almost always curable; neglected, it remains indefinitely as a menace to the sense of hearing and to life itself.

It needs to be clearly understood that the suppurating middle ear is not primarily a disease of the ear, but (almost always) an infection which has spread from the nose or pharynx. The infection may also spread to the openings in the mastoid bone, which are in reality continuations of the cavity of the middle ear, and there cause grave danger to life. It is to relieve this condition that the "mastoid operation" is performed.

Medical inspection reveals that an average of some 2 per cent of school children have ear-discharge, and the total number, counting those who have had the defect and recovered from it, amounts to 8 or 10 per cent. Denker found about 1 per cent of secondary-school pupils and 2 per cent of elementary pupils in Germany with present ear-discharge. The number who had had the defect at some time was approximately 12 per cent (9). Of 1006 poor children in three average East-End Schools of London, 7.3 per cent had present ear-discharge and 13.4 per cent additional showed symptoms (cicatrices) of previous discharge. Dr. E. B. Hoag finds that from 2 to 3 per cent have chronic ear-suppuration. Cornell places the number at 1 to 2 per cent. The proportion is usually smaller with older children than with younger, due probably to the better habits of cleanliness among older children and to the fact that their adenoids and enlarged tonsils have often had the necessary surgical attention. The greater cleanliness of older children also doubtless conceals a good many cases of the defect. On the whole, Burnham's estimate of 2 per cent does not seem excessive. This is not far from one case for each schoolroom, or a total of nearly a half-million in the schools of the United States.

The causes of ear defects

Apart from congenital deafness, which is nearly always due to heredity, defects of hearing have three main causes: (1) diseased conditions of the nose and throat; (2) infectious diseases; and (3) stoppage of the outer canal.

The first-named cause is by far the most important, accounting for considerably more than half of all cases.[1] The conditions of nose and throat most frequently involved are adenoids, enlarged tonsils, and chronic catarrh. Most cases of acquired deafness in children are due, directly or indirectly, to diseased conditions of the nose or throat. Neglected colds, adenoids, chronic catarrhal conditions, and infectious diseases which affect the throat (measles, scarlet fever, and diphtheria) are the chief culprits.

It will be remembered that the middle ear is connected with the pharynx by the eustachian tube, and that the mucous membrane of the middle ear is continuous with that of the eustachian tube and pharynx. In childhood the eustachian tube is relatively short, wide, and straight, making an easy road over which disease germs may travel from the throat to the middle ear. Inflammation of the throat, such as is present in colds, catarrh, or disease of the tonsils, sometimes causes swelling of the walls of the eustachian tube and interferes with the ventilation and drainage of the middle ear.

Normally, the mucus which is constantly being secreted by the membrane lining the middle ear is propelled through the eustachian tube by the wave action of the cilia. Disease of the mucous membrane, as in catarrh and the like, interferes with the action of the cilia and prevents drainage. When this occurs, two results are likely to follow: (1) the mucus of the

[1] Holmes says 60 per cent; Zhermunsky, 64 per cent; Burkner, 33 to 60 per cent; Cornell, 95 per cent; and Love, "nearly all."

middle ear (perhaps containing pathogenic bacteria) accumulates for lack of normal drainage to the pharynx; and (2) the atmospheric pressure on the two sides of the eardrum becomes unequal and may cause a rupture. The accumulated pus then escapes through the outer canal and we have what is called the "suppurating ear."

By early and thorough treatment of running ears many cases of deafness will be prevented. There is on an average about one case of ear-discharge in each schoolroom. The presence of cotton in the ear ought to excite the teacher's suspicion. Earache, although it may have other causes, is usually associated with acute inflammation of the middle ear. An aching ear is a signal of trouble; a discharging ear is a sign that the trouble has already occurred; a neglected discharging ear is a sign of progressive deafness.

As already pointed out (chapter XII), defective hearing is one of the commonest symptoms of adenoids. Deaf children are therefore extremely likely to be mouth-breathers. Yearsley's report of 1006 children in London showed mouth-breathing one third more frequent among the partially deaf than among those with normal hearing.

The next most common cause of defective hearing is acute infectious diseases, principally scarlet fever, measles, and diphtheria. These probably account for 10 to 20 per cent of all cases. In measles and scarlet fever the middle ear is nearly always affected to greater or less degree. Of 500 totally deaf persons studied by

Holmes, 36 cases were the result of measles. For years the writer has made it a practice in hygiene classes to ask the students how many know an individual who has defective hearing from this cause. There are few students who cannot name at least one such case. Children recovering from acute infectious diseases should be closely watched. Deafness, mastoid operations, and the like are complications which should never be allowed to arise.

It should also be emphasized that running ear following an infectious disease is always a source of danger to others, as the discharge may contain the germs of the disease in question. Epidemics of scarlet fever, measles, and diphtheria are believed to originate sometimes in this way.

Accumulation of wax in the outer canal sometimes takes place, but this cause is responsible for only a small percentage of cases. The accumulation is sometimes the result of a diseased condition of the outer canal causing profuse secretion and incomplete removal of the wax. Sometimes it is caused by pushing the wax against the eardrum in the effort to remove it with a pencil, hairpin, or damp cloth. Wax accumulations can be safely removed only by the physician.

Contrary to popular opinion, accidents to the eardrum do not ordinarily produce serious results unless the entire structure is destroyed. This is because the drum is endowed with such a remarkable growth power that the slight puncture, or rent, is quickly repaired. Complete recovery, in fact, may occur within a few hours. About 25 per cent of all adults have had a puncture of the eardrum. Even the total loss of the eardrum does not destroy hearing, though of course it greatly reduces it. One serious danger to the middle ear from loss of the eardrum is the increased danger of infection from without. In such cases there is nothing to block the entrance of disease germs.

Summarizing, we may say: —

(1) Deafness nearly always has its origin in childhood.

(2) In the vast majority of cases it is due to diseased conditions of the nose or throat, and is therefore usually preventable.

(3) The source of the trouble may be either (*a*) some chronic disorder of the throat, such as adenoids, enlarged tonsils, catarrh, etc., or (*b*) an acute infectious disease which involves the throat, usually scarlet fever, measles, or diphtheria.

(4) Wax accumulations and injuries to the drum are occasional but not very frequent causes.

The function of the school

We have found that from 10 to 20 per cent of school children have defects of hearing. One fourth of these cases, at least, are very serious. A considerable number are in danger of becoming entirely deaf; in other cases life itself is jeopardized. Instruction is rendered difficult, retardation may occur, and even the character of the child may be unfavorably influenced by the defect.

It is well attested that nearly all cases of acquired deafness have their origin in childhood and that a large majority are preventable. Estimates of the proportion preventable range from 50 to 80 per cent. Theoretically, at least, all the deafness due to acute infectious disease and to chronic nose and throat troubles (the two main causes) are preventable.

It is evident, therefore, that if we would prevent deafness the children are the only rational point of attack. The question that remains is merely how best to reach them.

There are only two institutions through which this may be done: the school and the home. If all parents were sufficiently intelligent to discover the defect, wise enough to appreciate its importance, and wealthy enough to secure the needed treatment, the function of the school would then be merely the negative one of avoiding injury to the child's ears. The facts, however, are the reverse of this. Parents very rarely discover the defect unless hearing is reduced as low as one third to one fourth the normal. They simply scold the child as listless or perverse. Other parents, aware of the defect, neglect it either from underestimation of its seriousness or from poverty. The school must undertake the work because it is the sole remaining agency.

The school's first duty is to ascertain what children have imperfect hearing. The teacher cannot be depended upon to do this by mere observation any more than the parent. She, too, overlooks the defect and blames the child for inattention or regards him as stupid. Tests of hearing are necessary, and should be given to all the school children each year. The test given when the child enters school is especially important.

When defective hearing has been discovered, its cause should be ascertained. This can often be done by the regular school physician, but in very many cases an examination by a specialist is necessary. Ear, nose, and throat specialists should be employed by the school for this purpose. When this is not done, much follow-up work will generally be required in order to persuade parents to seek the right kind of medical advice.

The next step is to secure the needed treatment. If adenoids are present, they should be removed. Enlarged tonsils and chronic catarrh should receive appropriate treatment. If the ear is discharging it must be cleansed and treated, usually for months.

The present methods for dealing with the latter evil are utterly inadequate. As a rule, parents lack the knowledge of hygiene and medicine which would enable them to appreciate the situation. Others, and these are very numerous, cannot afford the service of specialists at current rates and are reluctant to accept as a charity what they have not means to command. Even when a specialist is consulted, the tedious treatment which ensues (cleansing, syringing, etc.) is seldom carried out with the needed regularity and care. Physicians find that in most cases it is simply folly to expect a cure by this method. The only assurance of success in this direction is for the child to be taken several times a week to the physician's office or to the hospital for the necessary treatment. Aside from the question of expense, it is useless to expect that this will be done. Treatment is almost sure to be intermittent and to be discontinued too early. Each visit to the hospital may consume hours of time. Whether rich or poor, we are too busy and impatient to submit to such a tedious ordeal. The result is that nine tenths of the cases of ear-discharge among school children have been and are still being neglected.

The only solution of the problem lies in the installation of the school medical clinic for free treatment. This is England's solution, and it is the ideal one.[1] The child goes as often as necessary to the near-by clinic, and receives the necessary treatment at the hands of a nurse or doctor. There is little waste of time, no loss of school attendance, and a mere bagatelle of expense. Even this is borne by the city. Best of all, the treatment brings cure. The only objection is the fetish of "parental responsibility."

But theorize as we may about the danger of tampering with parental responsibility, we are confronted by this fact of neglect. The rights of children to health and happiness surely outweigh any possible danger the scheme involves to the parents' sense of responsibility. It is not a very lofty system of ethics which would per-

[1] By 1913, ninety-five educational authorities in England had established clinics for the free use of school children.

mit children to become deaf as a moral lesson to their parents!

Teachers and school nurses, as well as the medical inspector, should keep a sharp lookout for ear troubles. Children who return to school after an attack of measles, scarlet fever, or diphtheria need to be watched, and the first signs of earache or "thickness of hearing" should arouse suspicion. The same is true of children who are subject to chronic nose or throat trouble, who catch colds easily, etc. It is well for teachers to remember that the child who has earache may be in danger of deafness. Follow-up work to secure the removal of adenoids and the treatment of throat disorders cannot be too vigorously prosecuted.

The school itself can accomplish something by protecting the child from taking cold. Overheated and dusty schoolrooms, deprivation of physical activity, and the like predispose to just those conditions of nose and throat which give rise to so many cases of ear complication.

Children should be taught how to care for the ear, how to wash it without risk of pushing the wax back against the drum, not to probe into it, not to box the ear, pull it, blow into it, etc.

The teacher's voice should have sufficient force and carrying power to be heard without strain of attention in the rear of the room. Purity of tone and modulation, rather than loudness, are the essential qualities. The shrill voice is as objectionable for its poor acoustic properties as for its disagreeableness. Normal schools could well afford to substitute lessons in voice culture for some of their work in formal grammar. Classrooms should be built with proper proportions (not far from 24 × 28 feet), and should be located where outside noises will not disturb.

Directions for testing hearing

The expensive apparatus and complicated procedures sometimes employed for testing auditory acuity are not in the least necessary for ordinary school purposes. With a little care any teacher can make a sufficiently accurate test of a child's hearing in from three to five minutes. Either the "watch" method or the "whisper" method may be used. Each has its advantages and disadvantages, but on the whole the latter is perhaps somewhat more satisfactory.

For the whisper test a room at least twenty-five or thirty feet long is necessary. At this distance a rather low whisper is easily audible to persons of normal hearing. The pupils should be tested singly. The child to be tested should be placed in a chair at one end of the room with one ear toward the teacher. The other ear must be closed tightly with a rubber stopper or with clean cotton. If a stopper is used, it should either be disinfected for each child or replaced by a new one. If cotton is used, it should be rolled into a rather firm ball so that in removal remnants will not be detached and left in the canal.

The examiner should stand at the other end of the room and pronounce in a whisper of uniform loudness a list of words. Numerals chosen at random from 1 to 100 are suitable. The distance of the examiner should remain the same throughout the test, the acuity of hearing being represented by the percentage of whispers heard. If a majority of the children of a class can hear, for example, 10 out of a list of 20 whispered numerals, then 10 out of 20 is taken as the standard for normality. The ear that hears only 5 is accordingly recorded as half normal, etc.

This is known as the "method of constant range," as contrasted with "the method of extreme range." By the latter method, the examiner moves from a distance at which the sound is clearly heard to a point where it is no longer audible. The distance at which the sound entirely ceases to be heard is recorded, and the reverse procedure is then followed out. That is, the examiner begins at a point where the sound cannot be heard at all and moves closer until it is unmistakably perceived. The average of the two records thus secured represents the child's hearing range for this particular stimulus.

The method first described is preferable because it is less likely than the other to be vitiated by the reflection of sound from the walls. It does not, however, enable us to measure the hearing of children who are extremely deaf.

Whatever the method, and whether watch or whisper be employed, the standard is purely a relative one. Different watches, likewise the whispers of different people, vary much in loudness. Rooms also differ in acoustic properties. The teacher should take as her standard of normality the average performance of a majority of children of a class. Those who fall far below this are certainly not normal, and ought to be examined by the school doctor or by an aurist.

The tests should be given to all the children, not simply to those whose hearing is under suspicion. Children who are partly deaf become wonderfully adept at lip reading, guessing at meanings when only fragments of speech are heard, parrying questions, and the like, so that a high degree of the defect may exist without exciting suspicion in any but a close observer. It is not meant that the child consciously makes false pretenses of hearing. It is all simply an unconscious adaptation to a condition whose presence the child himself is ordinarily not aware of. The semi-deaf child is not conscious of his defect because he has no other standard of hearing than his own.

Special schools for deaf children

We must recognize the right of all children to a free education who are able to profit by it. This includes children of all degrees of deafness. The education, moreover, should be just that kind from which the child in question will derive the greatest benefit.

The education of deaf-mutes is usually provided for in state institutions, but thus far little provision has been made for the large number of children who are not entirely deaf, but who are yet too deaf to derive the maximum profit from the ordinary class.

As Dr. Love and Dr. Yearsley, two noted English authorities on this question, have urged for many years, the most imperative need in this field at present is for a more scientific classification of deaf children for educational purposes. According to Dr. Love, who has examined institutions for the deaf in all parts of Europe and America, a large proportion of those who are being educated in these institutions do not rightfully belong in schools for deaf-mutes. They are the children who have a considerable remnant of hearing or who became deaf several years after they had learned normal speech.

On the other hand, there are many children in the regular classes of the public schools who are entirely too deaf to be properly taught with normal children. This group probably includes somewhat more than 1 per cent of the entire school enrollment. Stewart,[1] on the basis of 12,200 children examined, places it at 1.16 per cent. Jones, in an investigation of 3300 children for the London County Council, reports 1.5 per cent. For this type of children special classes in the public schools are an absolute necessity. They should not be educated with deaf-mutes because they need the companionship of normal children. Berlin has had such a class since 1907 and London since 1910. The number of children who belong in such classes is at least ten times as great as the total number of deaf-mutes.

Deaf-mutes may also be taught in still other special classes of the day school, but the residential school has certain advantages. If the child's home environment is

[1] Quoted by Love.

good, the special day school is perhaps better, for the reason that companionship with normal people favors healthy social development. London has 500 deaf-mutes in special day classes of the public schools.

In whatever type of schools deaf-mutes are educated, we are not to suppose that all of them require exactly the same kind of training. Normal children themselves do not; and precisely because the deaf-mute is a deaf-mute and the difficulties of his education therefore multiplied a hundred fold, it is so much the more important that we base our methods on medical and psychological study of the individual child. We refer here especially to the choice between the two methods in vogue for the instruction of the deaf; the oral and the manual.

For a half-century the champions of these two methods have waged bitter warfare. It is now pretty well agreed that a majority of deaf-mutes can learn the oral method and that they need to do so. The question is chiefly whether this method should be made universal. It is so, practically, in Germany. But it is well attested that a considerable proportion of deaf-mutes succeed indifferently or fail altogether by the oral method. According to Love, some 15 per cent of deaf-mutes are mentally defective, and with these, the oral method is never very successful. Others, also, succeed badly with it. It is absurd to universalize a method merely because it works well in a majority of cases.

The rule should be, educate the deaf child in the highest type of school for which he is fitted. What this may be in any particular case can only be determined by a study of the individual child.

As Love points out, the deaf and the semi-deaf should have the advantages of a longer training than normal children. The school should get them earlier and keep them later. The school period could well extend from 3 to 17 years. The ideal pedagogy for the special classes here advocated remains to be worked out. If the education of deaf and semi-deaf children is ever to be placed on a sound basis, opportunities will have to be provided for the scientific training of those who teach them.

Children who are only slightly deaf can be taught in the same class with normal children, but they should be given an advantage in seating. This is a precaution which no teacher can ignore without grave injustice to the child concerned. In the average group of forty or fifty children from one to three will almost certainly be found in this group.

Mention should also be made of psychic deafness, i.e., defective ability to interpret sounds (usually speech sounds), without any defect of the vocal organs themselves. Slight degrees of psychic deafness are by no means rare, and the defect is usually one which responds in a remarkable way to special training. Sometimes it is mistaken for true deafness, especially in children whose associations have been mainly with deaf-mutes. The writer has found one such case, of mild degree, in the seven-year-old son of deaf-mutes.

This child, whose ears and mentality were both normal, was thought by his teachers to be both mentally defective and very hard-of-hearing.

Some indications of ear defects

Pupil often says "What?"
Inattention;
Stupid appearance;
Expressionless voice;
Poor spelling;
Poor progress in general;
Imperfect speech;
Complaint of earache;
Running ear (discharge often present without being easily observed).
Peculiar postures (in attempt to hear).
Difficult nasal breathing (often present with ear trouble).

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CHAPTER XIV

THE HYGIENE OF VISION

Written with the assistance of Dr. E. B. Hoag

New demands upon the eye

Excepting touch alone, the eye is the most valued of our special senses. The conservation of vision has been called "more important than all the work of our universities." At least one fourth of the inhabitants of Europe and America are more or less handicapped by defective vision. Since most of the instruction given in the schools is based upon the visual impression, it is well to examine the efficiency of the visual functions to ascertain the effects of school work upon them.

Most of the organs of the human body were molded in response to definite demands of life and environment. These demands are the measures according to which nature has fashioned us. The eye is no exception to this law. Generally speaking, each animal species has developed as good vision as its mode of life calls for, and no better. "Perfection for perfection's sake" is foreign to the economy of nature.

What kind of an eye did primitive man require? Plainly, one which would be effective chiefly for distant seeing, able to make as many as forty to fifty movements per minute, and one which could focus for a few minutes on near objects, if occasion demanded. For the bulk of the human race, little more than this was required of the eye until the last few hundred years. The eye was permitted, for the most part, to roam in freedom. It made only large movements and made them slowly. Fixation was rarely for more than a few seconds. When it tired of one kind of work it was usually free to change its activity.

Quite recently, however, the eye has been subjugated by the tyranny of print and sentenced to a treadmill form of action for which it was never originally designed. In five minutes of reading the eye makes, ordinarily, over one thousand separated movements and as many fixations, each with "rifle-aim precision." This is probably as much work as it was earlier required to do in one hour. The ciliary muscle, in accommodating the eye for near work, such as reading, probably expends as much energy in five minutes as formerly it was necessary to expend in a whole day of distant seeing. Moreover, the accommodation must shift in the reading of each line as the eyes move across the page from left to right, since only in the middle of the line are the two eyes equally near to the point of fixation. Add to these burdens the difficulties of too fine print, insufficient light, an unsuitable form of type, improperly colored paper, unhygienic spacing of letters, lines, or words, and the abuse to which the eye is now universally subjected at once becomes apparent.

The few generations since printing was invented have not sufficed for the evolution of a better eye. The new work must be done with tools which were fashioned for other purposes. Let us see with what success the work is done, with what cost of effort, and with what injury to the tools themselves.

The mechanism of vision

The eye, as every one knows, works upon the principle of the ordinary camera. The retina is the photographic plate, the pupil of the eye is the point of entrance for the rays of light, and the crystalline lens corresponds to the lens of the camera. The lens, of course, serves merely to bring the rays of light to a focus on the retina or photographic plate.

In the working of the visual camera four possibilities are always present: —

(1) The distance from the lens to the retina may be exactly sufficient to permit rays of light from distant objects (parallel rays) to be brought to a focus upon the retina. (Fig. 17.) This condition is called "emmetropia." The emmetropic eye is the ideal eye, for it permits objects distant more than a few feet to be imaged upon the retina with perfect distinctness while the eye is at rest.

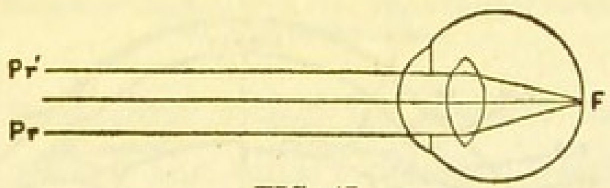

FIG. 17
Emmetropic or normal eye. Parallel rays focused on the retina

(2) If the distance from the lens to the retina is too short, the parallel rays strike the retina before they have been brought to a focus, thus giving a blurred

image. (Fig. 18.) This condition is "hyperopia," or "far-sight." Far-sighted people, however, do not see even distant objects clearly when the eye is at rest; though the farther away the object is, the less its image is blurred. Clear vision is possible for the hyperopic eye in one way only; namely, by an increase in the convexity of the lens sufficiently great to bring the parallel rays to a focus exactly on the retina. Fortunately, the crystalline lens is provided with a means for regulating its convexity. The action of this mechanism is known as "accommodation." Accommodation consists essentially in releasing the tension of the suspensory ligament of the lens through the action of the ciliary muscle. This enables the lens to increase its convexity by virtue of its inherent elasticity. When the ciliary muscle contracts, the pressure on the lens is in part released, permitting it, because of its elasticity, to assume a more nearly globular shape. (Fig. 19.) The nearer the object is to the eye, the more the ciliary

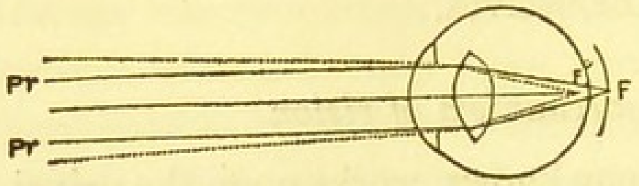

FIG. 18

Hypermetropic or long-sighted eye. Rays of light focused behind the retina

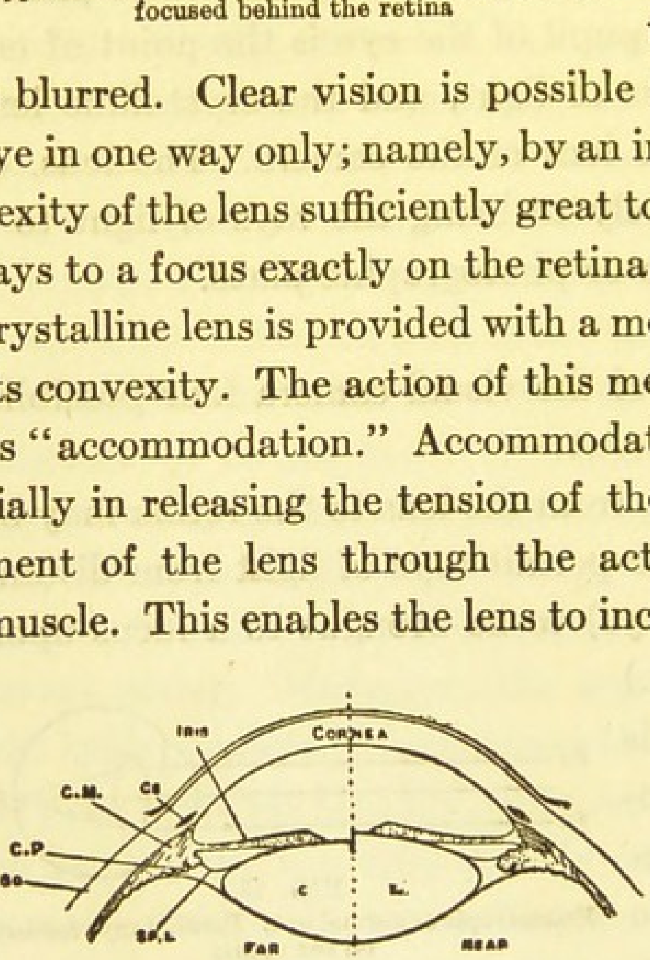

FIG. 19

Diagram to illustrate accommodation. On the left, the form taken by the lens at rest and viewing distant objects is shown; on the right, that when accommodated for near objects. Sc, sclerotic; C. P., ciliary processes; Sp.L., suspensory ligament; C.L., crystalline lens. (From Thornton's "Advanced Physiology.")

muscle must exert itself. It will be observed also that the emmetropic eye, the eye which focuses the rays from distant objects upon the retina without effort, must resort to accommodation when near objects are fixated. The normal eye can secure rest from the strain of accommodation simply by looking away from the book or other near object to something in the distance, but the ciliary muscle of the badly hyperopic eye ordinarily receives no rest. It can be relieved only by an artificial convex lens which, placed in front of the eye, takes the strain off the crystalline lens, so to speak, and places it upon the glasses.

(3) Sometimes the eye is too long from front to back, so that parallel rays are brought to focus before they strike the retina. (Fig. 20.) This condition is known as "myopia," or "near-sight." In myopia there is no possibility of clear vision for distant objects, since contraction of the ciliary muscle would increase the convexity of the lens and so make matters worse. Objects close enough are distinctly imaged in myopia. But however great the myopia and however badly it interferes with ordinary vision, no strain of accommodation results. The only eye-strain produced by myopia is the strain upon the oculo-motor muscles which are attached at the rear of the eyeball. These, in looking at very near objects, must exert a

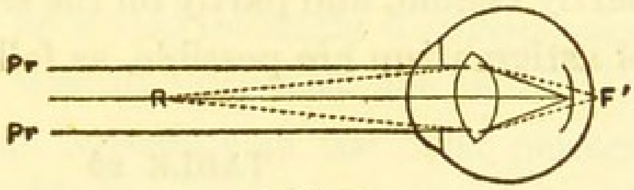

FIG. 20
Myopic or short-sighted eye. Rays of light focused in front of the retina

constant pull to converge the two eyes upon the object, held, as is often the case, but a few inches distant.

(4) In the simple myopia and simple hyperopia just described the source of imperfection lies solely in the length of the anterior-posterior diameter of the eyeball. If this diameter is too short, we have hyperopia; if too long, myopia. But there is another source of defect; namely, uneven curvature of the cornea or lens (usually the cornea). This is known as "astigmatism." In astigmatism the cornea (or else the lens) has "different curvatures in different meridians" (diameters), so that only blurred, or partly blurred, images are formed. The rays of light from an object may focus partly in front, partly behind, and partly on the retina. Five varieties of astigmatism are possible, as follows: —

TABLE 26

Varieties	Focus from one extreme diameter	Focus from other extreme diameter
Simple hyperopic	On retina and	Behind retina
Compound hyperopic	Behind retina and	Behind retina
Simple myopic	On retina and	In front of retina
Compound myopic	In front of retina and	In front of retina
Mixed	In front of retina and	Behind retina

If not too severe, most of the forms of astigmatism can be corrected, or partly corrected, by the action of the ciliary muscle. The same is true of hyperopia. If, in spite of the astigmatic or hyperopic shape of the eye, clear vision results by virtue of accommodation, we have the condition described as "latent astigmatism" or "latent hyperopia." Correction is made, but at the cost of eye-strain. When the strain becomes too great and correction is no longer possible, the defect is described as "manifest." Hence astigmatism and hyperopia are the two causes of overstrain of the ciliary muscle. Relief from astigmatism is secured by glasses ground in such a way as to have also "different curvatures in different meridians," but the reverse of the difference between the two meridians of the eye and so correcting it.

Let us now consider each of the above conditions in greater detail.

Emmetropia (*correct vision*)

No human eye is absolutely perfect, and few even approximately so. The great Helmholz [1] is said to have remarked that he would instantly discharge any laboratory assistant who had prepared for his use an optical instrument as imperfect as the most perfect human eye. George M. Gould claims to have found no perfect eye out of 10,000 pairs examined (8). Jackson (13) reports 51 eyes out of 4000 as emmetropic, or 1.3 per cent.

But nature's adaptations are seldom perfect, and faults of structure or functioning could probably be made out for almost any organ of the body. Slight imperfections of the eye do not greatly hinder vision, and from half to two thirds of the people get along fairly comfortably with the optical apparatus nature has given them.

[1] Physicist, physiological-psychologist, and inventor of the ophthalmoscope.

Not so, however, with a large minority. Of about 500,000 children examined in the elementary schools of London, 10 per cent had not more than one third normal vision. Examinations of 87,000 pupils in the Russian secondary schools showed that the incidence of myopia alone ranged from 8.8 per cent in the lower grades to 22.6 per cent in the highest.

Out of 79,065 children examined in the public schools of New York City (1906), 31 per cent are reported as having defective vision. For the entire State of Massachusetts (402,937 children) the proportion of children with defective vision was returned in 1907 as 22.3 per cent. In Cleveland (30,045 children) the proportion was 20.7 per cent; in Minneapolis (25,696 children), 30 per cent; in Worcester (11,953 children), 19.1 per cent; suburban schools near St. Louis (2000 children), 30.6 per cent. Dr. E. B. Hoag finds 30 per cent for 15,000 children in the towns and cities of Minnesota.

Statistics from about 165,000 school children in Japan gave the following results (18): —

TABLE 27

	Kind of school	Number examined	Defective vision
Boys	Middle schools	92,290	12.4 per cent
	Normal schools	11,963	16.6
	Technical schools	28,115	12.8
	Professional schools	1,631	28.8
Girls	High schools	27,191	9.4
	Normal schools	4,018	7.6

The above statistics, chosen from innumerable investigations in diverse parts of the world, amply demonstrate that from 10 to 30 per cent of the school population have vision sufficiently imperfect to demand correction by glasses. The conditions in different cities and countries are probably more uniform than the figures presented would indicate, the statistics depending in part upon the methods of testing and in part upon the varying standard as to the degree of defectiveness which may be safely disregarded.

Hyperopia (*"far-sight"*)

As already explained, hyperopia is due to a too short diameter of the eye from front to back. Examinations made by various investigators of more than 2000 day-old babies prove conclusively that hyperopia is the normal condition at birth (29). As age increases, the eye changes gradually from the condition of hyperopia to that of emmetropia (normal vision), and later, in many cases, to myopia. In London school children the proportion of hyperopia decreases rather regularly from 45 per cent at 6 years to 18 per cent at 13 years.[1]

Similar figures could be quoted in great number, but the following table of results from the *Gymnasium* at Altona, Germany, will sufficiently illustrate the law of decreasing hyperopia as the eye evolves.

[1] It is important to distinguish the hyperopia of childhood from the condition of far-sight commonly found in persons somewhat past middle age. The former condition is ordinarily due to the fact that the eye is undeveloped. The latter condition, known as "presbyopia," is due to the decrease in the power of accommodation which usually takes place after the age of thirty-five or forty years. Most persons at this age would do well to have the eyes tested for presbyopia.

TABLE 28

Age	Number hypermetropic
9–11	18.93 per cent
12–14	7.14
15–17	6.88
18–20	4.05
21–22	0.00

The significance of hyperopia lies chiefly in the strain it throws upon the ciliary muscle in the effort to produce accommodation. Another serious result frequently produced by hyperopia is "squint," or "cross-eye." [1] The emmetropic (normal) eye demands effort on the part of the ciliary muscle during "near work"; the hyperopic eye always. Any considerable degree of hyperopia, uncorrected by glasses, is therefore a constant source of eye-strain. It is much the same as if any other muscles were compelled to work without a moment's rest except during sleep.[2]

Whether hyperopia should be corrected by glasses depends upon the degree of the defect, the age of the child, and the general condition of health. Mild hyperopia in the early years is perfectly normal, and the only caution necessary in such cases is the avoidance of an excessive amount of near work. If the health is good, a fairly high degree of the defect may be corrected by accommodation without symptoms of eye-strain. On

[1] See p. 263.

[2] It should be stated, however, that if the degree of hyperopia is so great that the ciliary muscle cannot make even approximate correction, the effort of accommodation is relaxed and the eye accepts the blurred vision as inevitable. In this event there is poor vision without eye-strain.

the other hand, if the health is poor and the "tone" of the muscles reduced, a relatively slight hyperopia may give rise to marked symptoms. The oculist alone is competent to judge whether glasses are needed.

When the hyperopia is very great, correction by glasses is always necessary. Neglect of such children is nothing less than cruelty. The extremely hyperopic eye works as hard at distant vision as the normal eye at near work. Let the person with normal eyes focus them upon an object distant twelve inches and attempt to retain this focus for fifteen consecutive hours and he will gain an idea of the strain to which the extremely hyperopic person is all the time subjected. Little wonder that the nerves should be shattered and the general health disturbed by a strain so far beyond the power of any muscle to endure!

Myopia

No question in school hygiene has given rise to more controversy, or to more error, than myopia. Certain aspects of the problem which had been in dispute for over a hundred years are only now being cleared up, and the most erroneous statements are still common both in the literature of school hygiene and in medical treatises.

Over half a century ago it was clearly shown by Cohn that myopia increases rapidly in the upper grades, reaching often as high as 40 or 50 per cent by the age of 20 years. This, it was assumed, was due entirely to the near work of the school.

It was assumed further that myopia of any degree is pathological and tends to run a progressive course. "The myopic eye is a diseased eye, and the school is its cause," was the slogan of reform. It was believed that the defect was produced solely by the excessive convergence required of the eyes when a near object is fixated, the pull of the oculo-motor muscles on the coats of the eye at the rear gradually lengthening the eye-ball. The myopia thus induced would, of course, require objects to be brought still nearer the eye for clear vision, which, in turn, would require still greater convergence, resulting in increased myopia, and so on. This is what is meant by the statement that myopia tends to be "progressive," or to run in a "vicious circle." It was also emphasized that finally the excessive pull required for convergence would inevitably result in other pathological conditions of the coats of the eye.

Further proof of the contention that myopia is always pathological and that it is chiefly induced by the abuse of near vision was sought in statistics which purported to show that it is not present in primitive races, and that its frequency is always in proportion to the amount of near work required. Myopia came to be known as "school myopia."

The defect was even considered by some writers an important factor in character formation, causing, it was believed, stubbornness, melancholia, timidity, aboulia,[1] phobias of people or ghosts, superstition, etc.

[1] Weakness of the will resulting in inability to make decisions.

On the other hand, opponents of this view have contended that school statistics always exaggerate the amount of myopia through frequent failure to distinguish it from other forms of defective vision; that the much-talked-about pathological effects of myopia are discoverable only in rare cases; that severe myopia is not uncommon in children below school age and in uneducated peasants who have never gone to school or used their eyes for other forms of near work; and that whatever increase takes place during school life is in part the result of the natural evolution of the eye and in part represents a favorable adaptation of the eye to the demands made upon it. Some have gone so far as to assert that a moderate degree of myopia is the ideal condition, and that if it were possible to prevent myopia it would be a grave mistake to do so.

Space does not permit us to enter into the details of this interesting Hundred Years' War, the wavering fortunes of which, as recorded in the narrative of Wingerath (29), read like a modern Iliad.

Let us, if possible, escape the bias of the violent partisan and base our conclusions upon reliably established facts, remembering that the cause of school hygiene cannot be permanently served by an exaggeration of its claims.

Among the essential facts are the following: —

(1) Myopia is by no means unknown among primitive races, though its exact frequency has not been sufficiently established for many tribes.

(2) Investigations of eye conditions among army

recruits in Germany and Denmark have revealed the presence of all degrees of myopia in recruits who had never attended school or engaged in near work of any kind. Although most of these studies agree in finding a larger proportion of myopia among recruits who had attended school longest, one investigation, at least, finds exactly the reverse.

(3) The fact that myopia becomes much more frequent in the upper grades is admitted by all, but that the school is the chief culprit remains to be proved. The evolution of the eye from a condition of hyperopia to one of myopia has been frequently observed among those who have attended school little or none at all. The presence of more myopes in the upper classes is also partly accounted for on the theory that inasmuch as extreme near-sight unfits the child for ordinary distant seeing but leaves the ability to read little impaired, children with myopia are for this reason more likely to be retained in school and to crowd the upper grades.

The most reliable statistics, such as those of Redslob (21), Krusius (15), and Khlopine indicate that myopia is about as common in those types of schools demanding the least amount of near work as in those demanding most. Moreover, no very appreciable decrease in the proportion of myopes among school children seems to have taken place as the result of the modern crusade for school-hygiene reform, although remarkable advances have been made in school-lighting, bookmaking, etc. While it cannot be denied that the school may be one factor in the production of myopia, that it is the sole, or even the chief, factor can no longer be maintained.

(4) The investigations of Stilling, Steiger, Miss Barrington, and Karl Pearson amply demonstrate the hereditary character of myopia. On the basis of more than 5000 measurements made on cadavers, Stilling claims that the development of myopia is mainly dependent on the conformation of the bony socket of the eye, a low orbit predisposing to the defect. This, of course, is hereditary in the same degree as any other skeletal peculiarity.

(5) It will be impossible to clear up the mysteries of myopia as long as all kinds and degrees of the defect are thrown together for wholesale consideration. As regards both the cause and the results of myopia, it is necessary to distinguish two types: (*a*) pathological myopia, and (*b*) functional myopia.

Pathological myopia is usually of high degree and represents a definitely diseased condition of great seriousness. Of this type, it is correct to say that "the myopic eye is a sick eye"; and we may add that it is myopic largely because it is sick, not sick simply because it is myopic. This form of myopia runs a progressive course.

Functional myopia, on the contrary, is usually of low degree, appears ordinarily in late childhood or early adolescence, and becomes fully arrested before the age of twenty-five. The best authorities at present believe that this type of myopia rarely, if ever, passes over into the pathological type. It is a defect which, although it may handicap its possessor for certain kinds of work, is unlikely to have serious consequences. In all probability it is the joint product of two factors: (*a*) a low orbit (which is hereditary), and (*b*) an excessive amount of near work, such as reading, writing, sewing, etc. It has not been demonstrated that factor (*b*) operating alone is responsible for any large proportion of the cases.

(6) The functions of school hygiene with respect to myopia are fairly definite. In the first place, it is extremely important to identify those children who have a tendency to "pathological myopia." These should remain under the constant supervision of the oculist. In the second place, the school should do everything possible to clear itself from the suspicion of causing "functional myopia." Lighting, seating, textbooks, and the hygienic arrangement of the daily program, including rest periods, are the cardinal points here. If it is correct, as seems probable, that the chief cause of myopia lies in the shape of the eye's orbit, then it would be possible to identify in the first grade those who are likely to develop the defect later. Appropriate means could then be employed to safeguard such children from needless injury to their sight.[1]

Astigmatism.[2]

The discovery of astigmatism by Thomas Young over a hundred years ago, and the later demonstration

[1] See the admirable discussion of myopia by Professor W. H. Burnham, in Monroe's *Encyclopedia of Education*.

[2] For definition see p. 250.

by Donders that it is due to an error of refraction, constitute, together, one of the most important medical advances of the last century. Astigmatism is responsible for more than half the cases of seriously impaired vision and for the majority of cases of eye-strain.

In the period 1908–11, the school physicians of Strassburg referred 2033 children to the school oculist for special examinations. Among these there were 679 eyes hyperopic, 588 myopic, and 1496 astigmatic. Astigmatism was, therefore, more than 17 per cent more frequent than hyperopia and myopia combined.

Few eyes are entirely free from astigmatism. Of 2307 school children examined by Dr. Stocker, in Lucerne, Switzerland, 96.7 per cent had astigmatism of at least .25 D in one or both eyes. Statistics usually show that not far from 10 or 15 per cent of the school children have astigmatism sufficiently great to impair vision seriously. The statistics secured by Steiger (24) are typical. In the cities of Zürich and Berne (Switzerland), 7736 children out of 25,995 whose ages lay between 6 and 8 years were referred to the school oculist, Dr. Steiger, for examination. Of these, 2406, or slightly less than 10 per cent of the 25,995, were found to be markedly astigmatic.

Some forms of astigmatism impose a peculiarly difficult task upon the ciliary muscle in the effort of correction. Sometimes it causes faulty posture, since the child sees more clearly in one meridian than in the other and so turns the head to one side in order to take advantage of the meridian of clear vision. It is possible that preferences as regards handwriting slant are sometimes caused by the astigmatic eye choosing that slant which makes the individual lines stand out most clearly.

Whether the child with a moderate degree of astigmatism should be advised to secure glasses depends in large measure upon the state of health. In some children, rather severe errors of refraction cause no discoverable symptoms; in others, marked symptoms accompany slight errors. Some eyes have little power of correction, and some nervous systems are more subject to reflex disturbances than others.

There is no evidence that astigmatism is caused by the school, though of course near work adds very greatly to the burden of the astigmatic eye and aggravates the symptoms of strain. The cause, in most cases, is the pressure exerted by the eyelids upon the ball. Astigmatism in the opposite direction, "contrary to the rule," is much more rare in children than in adults, making up only 2.9 per cent of all the cases of astigmatism found by Redslob (21).

Muscular deviations

The muscles which move the eyeball are subject to three common varieties of disturbance, resulting respectively in squint, unbalance, and muscular insufficiency. The cause of squint and unbalance is usually some form of ametropia (i.e., far-sight, near-sight, or astigmatism), and not chiefly an anatomic defect in the muscles or their attachment, as was formerly believed. Paralysis will, of course, produce muscular deviations, but aside from this the cause is usually some refractive error.

Squint, or "cross-eye," is a particularly serious condition of muscular disturbance often observed in school children. The experience of Dr. E. B. Hoag indicates that it can be detected in about 2 per cent of the school enrollment by means of ordinary observation, without the use of any optical instruments. Cornell estimates that it is present in from 3 to 6 per cent (5), while Butterworth finds that it ranges around 2 per cent.

In the majority of instances, squint is caused by congenital and excessive hyperopia in one of the eyes. The child early learns instinctively to disregard the "bad eye," which is soon turned up, down, in, or out. As a result, the power to focus is soon lost in this eye, and if proper glasses are not obtained before the child is 6 or 7 years old (or even earlier), the sight of the crossed eye is usually greatly reduced or even lost altogether. Some believe that the reduced vision comes solely from disuse; others that it is occasioned by a lack of development in that portion of the brain which is concerned with the vision of the eye.

If the eyes are to be straightened without operation and the sight saved, glasses and treatment must be provided at the earliest possible moment, even if the child is still an infant in arms. Every medical examiner sees many cases of squint in which the vision is almost or quite destroyed in the eye affected. Parents and teachers rarely understand the situation, and are astonished to learn that the child's vision is already seriously affected or past repair.

The study of Butterworth, already mentioned, is perhaps the most valuable in this field. Of 14,739 children whom he examined, 3 to 13 years of age, 2.2 per cent had the defect. The number increased from 3 to 6 years, after which it remained practically stationary. We may say, therefore, that if the child has binocular vision when he enters school, he is not likely to lose it later. The left eye, for reasons unknown, was affected nearly twice as often as the right eye. Only one fifth of Butterworth's cases had ever used glasses, and only the insignificant number of one twenty-fifth of these had completely regained binocular vision, the treatment in most cases having come too late.

Many individuals suffer from slight unbalance of the oculo-motor muscles without noticeable squint. In such cases there is either constant or occasional impairment of binocular vision, and always a nervous strain from the effort to balance the eyes in maintaining steady focus. The strain may be unnoticed and binocular vision retained as long as health is good, while after an illness or during extreme fatigue the nervous symptoms of strain may appear and binocular vision become intermittent or altogether impossible.

Eye-strain in relation to visual defects

As already explained, eye-strain may result either from (*a*) overuse of the ciliary muscle in producing accommodation, or (*b*) excessive effort on the part of the oculo-motor muscles in maintaining eye-balance and producing convergence. The former is the more common cause.

The strain of accommodation is constant in the hyperopic eye, and is more severe the nearer the object is which is fixated. Astigmatism nearly always results in greater or less strain. In the normal eye, also, there is strain of accommodation as long as near work is being performed.

Due to the power of accommodation, not all people who have imperfect eyes suffer radical impairment of vision. Excessive use of accommodation in far-sighted and astigmatic persons, however, always finally results in eye-strain. This is particularly likely to occur in those individuals whose work requires considerable near vision. In outdoor work requiring only little use of the eyes for near vision, no symptoms may appear even in the case of serious defectiveness, provided the general health is good.

The close relation existing between general physical condition and the power of accommodation is well demonstrated by the experiments of Bauer.[1] Testing the range of accommodation at different times in the day, before and after various kinds of work, Bauer finds that it closely parallels the daily course of physical and mental efficiency and serves as an excellent measure of fatigue. The accompanying figure from Bauer, in which vertical distance represents the range of ac-

[1] *Die Ermüdung in Spiegel des Auges.* 1910.

commodative power and horizontal distance refers to the time of day, shows the intimate connection between fatigue and the functional capacity of the ciliary muscle.

There are few things more important for the teacher to understand than the injuries produced by eye-strain,

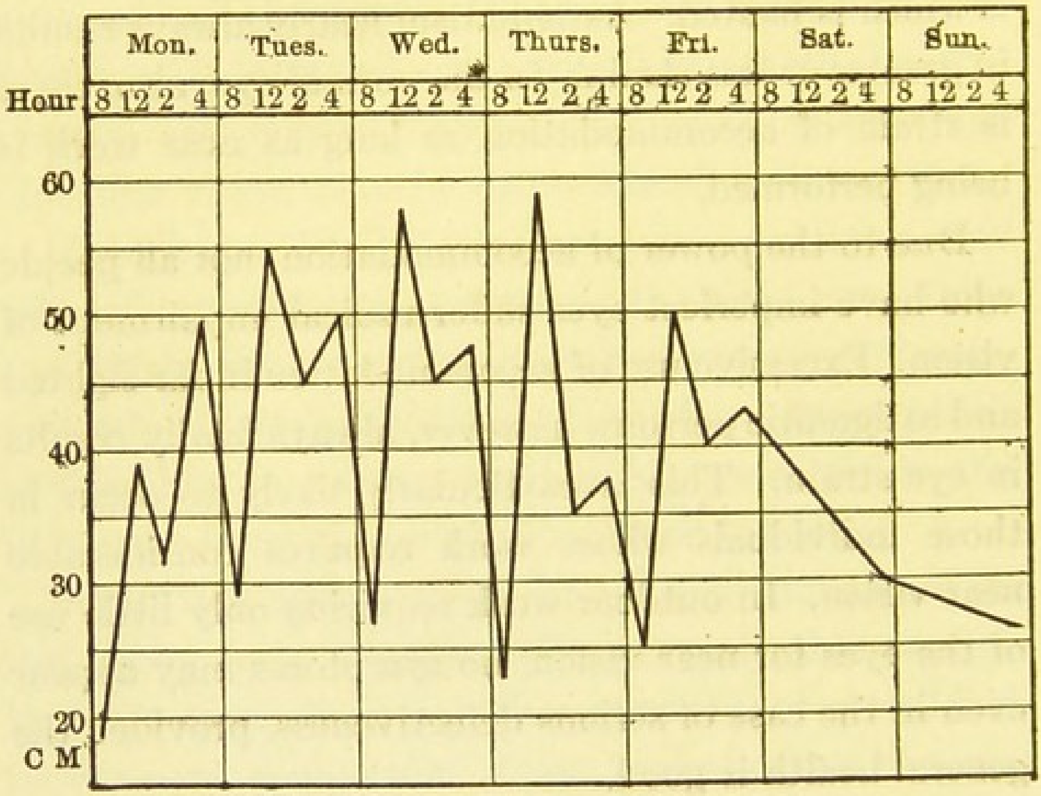

FIG. 21

Showing the daily curve of fatigue for eye accommodation during an entire week for one subject. Vertical distance, represented in centimeters, shows the distance for which accommodation was possible at different times in the day. Greater vertical distance corresponds to a higher degree of fatigue. Note that accommodation is best at 8 A.M. and worst at noon. Note absence of fatigue on Saturday and Sunday.

since it not only produces local symptoms and imperfect vision, but through its reflex effects may also undermine health altogether. It would almost seem as if the whole reservoir of nervous energy could be exhausted through this one small leak.

The signs and symptoms of eye-strain may be classified as local or general. The chief local manifestations are: —

(1) Painful eyes;
(2) Spasms of the eyelids;
(3) Itching, smarting, or watering of the eyes;
(4) Congestion of the eyes;
(5) Sensitiveness to light;
(6) Frowning;
(7) Blurred vision.

In regard to blurred vision, some interesting and very significant answers are obtained when children in the schools are asked the question, "How does the print look to you?" The following are representative verbatim answers recorded by Dr. Hoag in his work with thousands of pupils in California and Minnesota. Of one group of over 5000 pupils thus questioned, 23 per cent gave such answers as the following: —

"The letters all run together."
"I see two lines instead of one."
"I see one letter on top of another."
"The letters look crooked."
"The print seems all jumbled up."
"The letters jump up and down."
"After I read awhile, I can't find my place any more."
"The print looks like a big blot."
"The letters seem like a fog was over them."
"The letters look half up-side-down."

The reflex, or general, symptoms of eye-strain are legion. Among the most important are: —

(1) Headache (often with nausea);
(2) Feelings of exhaustion and weakness;

(3) Indigestion (sometimes constipation);

(4) Dizziness;

(5) Sleeplessness;

(6) Neurasthenia (fatigue of the nervous system);

(7) Motor disturbances, such as twitching, automatisms, stuttering, etc.;

(8) Irritability, lack of emotional control, outbreaks of temper, etc.

Of the reflex symptoms, headaches are the most important. Cornell finds that 31 per cent of those who have eye-strain suffer frequent headaches. Conversely, headaches (particularly those localized in the frontal region of the head) should always suggest the possibility of eye-strain.[1]

It is quite generally admitted that eye-strain is sometimes responsible for one or more of the other general symptoms above listed, though not all are ordinarily present in any one case. There is reason to believe, also, that it may occasionally act as the proverbial "last straw" in the production of chorea, habit-spasms, moral delinquency, or even functional epilepsy.

Teachers should never forget that ability to read the vision charts at the normal distance is no guaranty that eye-strain is not present. In many cases of fairly severe hyperopia and astigmatism, the child is able to read the chart simply by bringing an excessive amount of accommodation into play. The only means of ascertaining the actual refractive error of the eye, and therefore the amount of strain to which it is subjected, is to

[1] See chapter xv.

prevent accommodation during the test by paralyzing the ciliary muscle. This the oculist accomplishes by dropping into the eye one of the forms of belladonna.

Since this precaution cannot be taken in routine examinations of eyes by the teachers or school doctors, it is extremely important that the teacher be able to supplement the tests by the detection of the general and local symptoms of eye-strain. Because of her constant presence with the children during their near work, the teacher is in better position to discover such symptoms than the school doctor or any one else. Children in whom teachers observe either general or local symptoms of eye-strain should be referred to the oculist for thorough examination. There should be a school oculist for this purpose. If there is none, the parents should be urged to avoid the risky but common practice of consulting an optician.[1] There are so many possible sources of error in prescribing for glasses,[2] that only the expert should be entrusted with it.

Directions for testing the vision of school children[3]

In testing the eyes of children in the schools no elaborate optical apparatus is essential, or, indeed, desirable. The tests may and ought to be made by every teacher and the results carefully recorded for use. Dr.

[1] An oculist is a physician who has specialized on the diseases and disabilities of the eye. An optician is a person who makes or sells glasses.

[2] At least seventy-eight, according to Dr. Gould.

[3] This section has been prepared with the assistance of Dr. Frank Allport, of Northwestern University, to whom the author is indebted for many kindnesses.

Frank Allport, Dr. R. C. Cabot, Dr. Myles Standish, Dr. Clarence Blake, as well as other physicians and oculists, have long contended that the ordinary routine examinations of the eyes should be undertaken by teachers and school nurses. The teacher can make the tests fully as well as can the physician who is not also an oculist, and by virtue of her constant opportunity to observe the symptoms of eye-strain among her pupils she is in even better position than the school doctor to single out the children who need to be referred to an oculist. The tests will reveal the worst cases of defective vision, and symptoms of eye-strain will reveal many others if the teacher is observant. In the words of Allport, "Teachers should not attempt to diagnose diseases, but by means of simple tests, tests which can be given by any one with intelligence enough to teach, they can detect almost all serious diseases and defects of the eye, ear, nose, and throat. The doctor consulted will do the rest."

By this means, all the pupils of a school system, however large, can be tested for vision in one day; or, if preferred, a few pupils can be examined each day until the work is completed. "The teacher should by no means regard such tests as a hardship. By giving only a little time to them she will lighten her labors by sometimes transforming the nerve-exhausting, bothersome, and retarded pupil into one who is easily taught and ordinarily tractable."

For carrying out these tests each school should be supplied with one of the standard eye-charts made for this purpose. The Allport charts are to be recommended for the reason that they are designed for the special use of teachers and nurses. Full instructions are printed at the bottom of the chart. This part may readily be detached and kept before the examiner for convenient reference while the test is being given. The Allport charts have also the advantage of cheapness, the price quoted being but seven cents each in quantities of ten or more. Single charts may be had for twenty-five cents. At the price of seven cents there is no school system which cannot afford to supply a vision chart for every classroom.[1]

In testing the eyes of young children the cards devised by McCallie are very desirable.[2] These consist of a series of small cards on each of which is a boy, a girl, and a bear. The test requires the child to tell who has the ball (a black dot visible at twenty feet).

In no case should the vision test be made when the child has a cold in the eyes, or when they are inflamed from other causes.

Teachers and nurses will do well to be cautious in recording the results of vision tests, as there is a constant tendency to overestimate the number of defects. All children are likely to miscall and transpose certain letters, and this must be taken into account. It is only required that the child read the majority of the letters at the required distance without undue hesitation. In

[1] The charts may be purchased of F. A. Hardy & Co., Wabash Avenue, Chicago, Illinois.

[2] Edwin Fitzgeorge, agent, Trenton, New Jersey.

general it will be discovered that, when tested by the rough methods here indicated, from 15 to 30 per cent of school children have defective vision. Results which run much above or below these figures must ordinarily be suspected of containing error.

For practical purposes the chart for testing astigmatism is of little value in routine school work. The absolute necessity of observing and recording every case of crossed-eye should not be forgotten.

Sometime before the child leaves school he should also be given the test for color-blindness. This is best done by means of the Holmgren wool test. To make the test quickly, place before the child a green skein of Holmgren worsted and have him match it from a bunch of "confusion skeins" of different colors. If this is done quickly and without hesitation the child is passed.[1]

About 4 per cent of the boys and one half of 1 per cent of the girls are more or less color-blind, inability to distinguish red and green being the most common form of the defect. Tests for color-blindness are quite necessary in the case of those who expect to take up such work as railroading, marine service, medicine, painting, chemistry, mineralogy, certain mercantile businesses, etc. Simply to let the child name the colors of things shown him is not sufficient. Color-blind persons often learn the right names for colors merely by their differences in brightness, while, on the other

[1] More accurate tests for color-blindness and color-weakness may be found in Whipple's *Manual of Mental and Physical Tests.*

hand, some children who are not color-blind do not know the names for the different colors. Hence the necessity of the Holmgren test.

Summary and conclusions

(1) From 15 to 30 per cent of school children have seriously defective vision. This would mean that in the public schools of the United States there are from 3,000,000 to 6,000,000 such children.

(2) It is now known that the part played by the school in causing eye defects is not as serious as it was formerly believed to be. This is particularly true of myopia, in the production of which the shape of the orbit of the eye (which is a matter of heredity) is probably the leading factor. Near work, however, favors the development of the defect.

(3) While the school is not a leading cause of refractive errors of vision, its responsibility in relation to the eye is very great. This responsibility lies chiefly in the avoidance of eye-strain. The biological development of the eye has not fitted it for the kind of work which the school predominantly requires. Eye-strain is usually present in astigmatism and hyperopia, and the normal eye itself may suffer strain from the abuse of near work.

(4) Eye defects are intimately related to faulty posture, both as cause and effect. Myopia often leads to stoop shoulders, and astigmatism is one factor in producing lateral curvatures. Conversely, stooping postures and habits of holding the book too near the eyes

often cause eye-strain and favor the development of functional myopia.

(5) Tests of vision in the school should be made by teachers and school nurses. This not only results in a great saving of expense, but is the only plan which gives the teachers the intimate knowledge which they need to have regarding the eye conditions of their pupils. By linking this knowledge with the daily observations of eye-strain symptoms, teachers will be better able than the school physician to single out those children who need to be examined by an oculist.

(6) Schools have not paid sufficient attention to the correction of eye defects. Too often the parents neglect the advice of the school altogether or else resort to the optician for prescriptions. The experience of Strassburg, Zürich, Berne, and certain English cities proves conclusively that the one effective way to secure results in this field is by the employment of school oculists in sufficient numbers to make a thorough examination of all the cases of defective vision discovered by the teacher, nurse, or school doctor. Where this is done, practically all the children who are advised to do so present themselves for such examinations and nearly all secure the glasses needed. By the plan usually followed in America seldom more than 30 to 40 per cent of the eye defects are reported as treated, and the proportion of adequate treatments must be very low indeed.[1] A further guaranty of results is the plan, quite preva-

[1] See Gulick and Ayres, *The Medical Inspection of Schools*, 1913 edition, pp. 92 *ff*.

lent in England, of supplying the glasses at wholesale prices, or even gratuitously in cases of poverty. A great saving is thus effected, and the purpose of the whole scheme of effort is attained to an extent possible in no other way. The argument that the private practitioner may suffer from the adoption of this plan has no weight. Eye defects, like all others which afflict school children, are to be conceived as an evil to be corrected, not as a resource to be conserved for the benefit of private individuals.

(7) The school should take greater precaution than it ordinarily has done to secure the early diagnosis (and correction) of refractive errors. It is foolish to withhold relief until eye-strain has aggravated the defect and jeopardized the entire health of the child. The examinations in the first school year are, therefore, especially important.

(8) The defect once discovered, its course should be followed from year to year. The child's eye is a developing eye, and the glasses, in many cases, need to be changed occasionally.

(9) When the condition of the eyes is such that sight is likely to deteriorate gravely or to be lost, the child's parents should be fully informed and the education of the child should be especially planned to prepare him for this contingency. The remnant of vision which remains should be utilized in preparation for the darkness which is to follow. Special schools are, therefore, desirable for the children who do not quite belong in an institution for the blind, but whose vision is too

seriously impaired to enable them to profit normally from the instruction of the regular class.

(10) The lighting of the schoolroom is often far from adequate. The light should amount to ten meter candles at the darkest corner of the room. To secure this in all kinds of weather and at all seasons, the window space should ordinarily be not far from one fourth of the floor space.[1] The light should strike the desk from the left and rear, never from the front. Spots and streaks of direct sunlight should be avoided. The ceiling should be almost white and the walls a light buff. Beamed ceilings and low windows are never permissible in schoolrooms. Window shades are often quite necessary, but they need to be managed with great care to prevent streaks of light, the shutting-off of lights from the wrong part of the window, too much darkening of the room, etc. They should be of linen and of light yellow color. Nothing can be worse than the usual opaque, green shade.

(11) Since school work, at best, is likely to result in abuse of the visual mechanism, special attention should be given to such matters as rest periods, size of handwriting, the hygiene of textbooks, etc. All children should be taught to look off the book frequently. The morning session of three hours should be broken by two outdoor recesses of at least ten minutes each, and the

[1] Tests show that an average schoolroom in the central part of the United States may receive only about 18 per cent as much light in December as in June, and only 27 per cent as much at 4.30 P.M. as at noon.

afternoon session by at least one. The rôle of the eye in school instruction should be reduced to a minimum and more effort should be made to reach the mind through the ear and through the motor-activity. It is the duty of the school to teach children habits of economy in the use of the eyes.

Schoolbooks should be made of white paper, without gloss; the lines should be short (preferably about three inches), the margins wide and the print large. The following samples, according to Shaw and Huey, illustrate the minimum standards as regards size of type, spacing, etc.

"Then there is a turn in the road. The long train runs over the bridge and swings round behind a hill.

"The children cannot see it now."

Minimum standard for first year

(Size of type at least 2.6 millimeters and width of leading 4.5 millimeters.)

"She must climb the tree. She held on, first to one branch and then to another, and tried to reach the golden plums. Her hands, her face, and her feet were scratched and torn by the thorns."

Minimum standard for second and third years

(Letters not smaller than 2 millimeters, with a leading of 4 millimeters.)

"On the way down, an Indian who was in a canoe stole something from the ship. One of the crew saw the Indian commit the theft, and, picking up a gun, shot and killed him. This made the other Indians very angry and Hudson had several fights with them."

Minimum standard for fourth year

(Letters at least 1.8 millimeters, with leading 3.6 millimeters.)

(12) The handwriting should be large and oval. In the first grades blackboards should largely replace book and pencil.

(13) It is imperative to remember that the eye of the school child is an undeveloped eye, and that for this reason it should be protected from overwork.

(14) On leaving school, children with defective vision should have vocational advice. Much good would be done in such cases by placing in the hands of child and parent a card on which are listed the leading trades and professions in order of their tax upon vision.

(15) Children whose eyes are inflamed or discharging, or whose eyelids are swollen and red, should be

referred to the school physician for examination. There are many cases of contagious eye disease in the school, and for this reason the common towel should be abolished.[1]

Some indications of eye defects

Crossed eyes;
Peculiar head postures;
Frowning;
Holding book near the eyes;
Difficulty in reading the work on the blackboard;
Congested eyes;
"Sore eyes," or granulated lids;
Sensitiveness to light;
Headache (one of the most common symptoms);
Fatigue;
Nervousness;
Poor spelling;
Poor reading (miscalling words, etc.);
Blurred vision;
Double vision;
Scars on cornea (usually from ulcers);
Complaints of seeing colors or movement of letters or lines.

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CHAPTER XV

THE HEADACHES OF SCHOOL CHILDREN

Frequency

HEADACHES seldom appear before school age, but in later childhood and throughout adolescence they are one of the leading symptoms of an unhealthy nervous condition. The Norwegian Commission of 1891 found occasional or frequent headaches among 27 per cent of the children of the secondary schools, 8 to 18 years of age. The investigations made in the same country by Holst and Magelssen ten years later gave 17 per cent. Hertel's study of morbidity in the secondary schools of Copenhagen showed an average of about 7.5 to 14 per cent of the boys and from 7 per cent to 30 per cent of the girls suffering from headaches, the proportion for both being considerably higher for the ages 12 to 16 than for any other years. Schmid-Monnard's data for headaches and other nervous states, taken together, are presented on pages 383–84. For 103,666 children in the secondary schools of Russia, Khlopine found a gradual increase in frequency of headaches from 6 per cent in the lowest grade to 12 per cent in the seventh. Of 10,000 Minnesota school children questioned by Dr. E. B. Hoag, 25 per cent suffered "frequently" from headache. Among untold thousands of children headache is a chronic ailment.

Causes

The great excess of headaches in the Swedish classical schools, as compared with schools of other types in the same country, has usually been interpreted as a direct result of the closer application to books and the somewhat longer study hours of the classical schools. This theory, however, does not satisfactorily explain the distribution of headaches in Russian schools as shown in the following table from Khlopine: —

TABLE 29

Type of school	Number of pupils	Per cent with headaches
Boys' schools —		
(*a*) Classical	44,184	8.
(*b*) Modern language	22,539	7.9
(*c*) Technical	2,228	13.9
Girls' schools	44,029	11.25

The authors of the investigations quoted above are unanimous in placing the responsibility for headaches partly upon the school, and the relatively higher incidence which they have found in the upper grades and in schools with the most difficult programs bears out this claim. However, the investigations in Norway by Holst in 1901 and by Magelssen in 1904 have given results not altogether in harmony with this theory (4). Both these studies show about the usual incidence, varying from 10 to 23 per cent, but fail to show any increase in the higher grades to correspond with the increase in number of hours of school and home study. Magelssen even finds a steady decrease from the first to the fourth grade. This decrease was also more marked for severe and prolonged headaches than for the light and transitory. It should be noted, however, that the latter studies were by no means so extensive as the others. Moreover, Magelssen himself concludes that, although the school's responsibility for children's headaches has been exaggerated, school life nevertheless favors the appearance of headaches in children who are predisposed to them.

A careful study of the most recent and authoritative medical literature on this subject suggests that the underlying causes of headaches are poorly understood; "shrouded in darkness," as Magelssen puts it. In fact, headache is not only one malady, but many, since it arises from a large variety of causes. Hardly any organ of the body but may, when diseased, give rise to a headache. As stated by Woods Hutchinson (3), "the head, in its vicarious sufferings, is continually doing fire-alarm duty for the other parts of the body." The significance of headaches depends strictly on the individual factors concerned and hardly lends itself to discussion in general terms. In most cases, however, it is connected with one or more of the following conditions: —

(1) Anæmia. All the writers agree that there exists a close connection between headaches and an impoverished condition of the blood, though of course the two are not always associated. Nearly all anæmic adolescent girls suffer occasional headaches, while those with good blood and habits of outdoor activity seldom do.

(2) Reflex irritation. This is one of the most important causes, and includes eye-strain, impacted or cari-

ous teeth, adenoids, nasal catarrh, etc. Eye-strain is the most important of this group.

(3) Toxic conditions of the blood due to constipation, recent or approaching illness, excessive fatigue, etc. Of these, constipation and the accumulation of fatigue toxins due to habits of inactivity are the factors with which the school is most concerned. Constipation ranks with eye-strain as one of the most frequent causes of headaches.

(4) General nervous instability, due either to hereditary or acquired defect of the central nervous system. This is one of the most fundamental factors, and one which is operative to greater or less degree in nearly all classes of headaches. Neither temporary anæmia, nor impacted teeth, nor eye-strain, nor all these together will necessarily be productive of headaches in the otherwise healthy child. But the child who is characterized by general weakness, growth deficiency, or nervous instability falls a victim to headaches from apparently trivial causes. An examination of the heredity of such a child usually brings to light an unusual number of neurotic tendencies in the family stock: migraine, neurasthenia, hysteria, susceptibility to shock, etc. Gout and rheumatism are also frequently associated with the neurotic disorders. It is for this reason that headaches are here classed and treated with the general group designated as nervous defects, even though medical treatises for the most part have referred only migraine to strictly nervous causes. The newer developments in the functional aspects of psy-

chopathology, represented by Freud, Jung, Ernest Jones, and others, are rendering the once rigid distinction between nervous and non-nervous headaches more and more difficult to maintain.

Migraine is a headache characterized by its excruciating severity and by the physical prostration which accompanies it, though it may not be as lasting or as frequent as is likely to be true of headaches of other types. It is often preceded by certain premonitory symptoms, such as slight dizziness, misty vision, difficult language articulation, and aphasia. After a half-hour or so these symptoms subside and the pulsating throbs of headache begin. The child prefers to lie perfectly quiet with head turned from the light. The face is haggard and the pulse weak. Nausea, sometimes with vomiting, is common. After a few hours the pain subsides, sleep comes on, and the patient finally awakes fully recovered, except, perhaps, for a slight feeling of weakness or apathy.[1] With both boys and girls, nervous headaches tend to recur periodically. The evident hereditary kinship of migraine to other nervous diseases throws far more light upon its causes than does its occasional association with eye-strain or toxic conditions of the blood. At the same time, there is no doubt that both the frequency and the severity of migrainous attacks can to no small degree be controlled by a careful hygienic regimen, though not so completely as other types of headaches.

[1] See Leonard Guthrie, *Functional Nervous Disorders of Childhood*, pp. 150–52.

Prevention

In whatever form the malady shows itself, the important thing for teachers and school physicians to understand is that a headache means something. Instead of treating the headache, as such, the underlying causes should be investigated. It is well, first, to look to the habits of life; second, to the condition of the eyes; and third, for other unfavorable physical conditions and indications of overpressure. Worry, insomnia, and gastro-intestinal disturbances act as both cause and effect. Plenty of exercise in the open air, baths, ample sleep, a well-selected diet, attention to adenoids, nasal catarrh, eye-strain, and defective teeth, coupled with a thoroughly hygienic school program, would probably enable all but the most neurotic constitutions to escape the affliction. Headaches are not made inevitable by a bad heredity. In the schools of Christiania, headaches decreased in frequency about 40 per cent between 1891 and 1901, a fact which Magelssen thinks is due entirely to the introduction of medical supervision, school lunches, and a considerably lightened program. As long as 10 to 20 per cent of our children suffer from this defect, the school cannot escape the duty of using every available means to combat it.

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CHAPTER XVI

PREVENTIVE MENTAL HYGIENE[1]

I. THE NERVOUS CHILD

THE insane population of the United States amounts to about 200,000 persons. A few years ago most of these were children enrolled in the public schools, and we may well raise the question whether an educational régime specially adapted to their needs could have preserved any considerable proportion of them from their sad fate.

Sanity is a relative term. Where one becomes insane, a dozen develop harmful idiosyncrasies, or a lack of that balance which characterizes the efficient, reliable, and responsible person. Minor mental abnormalities, far from being rare, are seen on every hand; excessive irritability, unbridled emotionalism, alcoholism, certain criminal tendencies, obsessions, unreasonable fears, absurd prejudices, neurasthenia, hysterical suggestibility, etc. Mental balance is the exception, not the rule. Disregarding the inevitable imperfections and minor disharmonies of control, there are millions of people whose daily behavior does not justify a claim to average sanity. When our conceptions of

[1] The author is indebted to Dr. E. B. Huey for many valuable suggestions in the preparation of this chapter.

the neuroses are sufficiently enlarged, they will include in the class of nervously afflicted a large proportion of the criminals, industrial failures, and other inefficients. At least 5 per cent of our school children are neurotics in the sense that they are more than ordinarily predisposed to the development of mental "complexes" unfavorable to the healthy and coördinated functioning of intellect, emotions, and will.

Some nervous disorders purely functional

We are indebted to the functional point of view in modern psychiatry for opening up a new world of educational principles and suggestions. As long as mental disorders were considered solely from the standpoint of disease, and explanations were sought purely in terms of pathological organic conditions, the certain tendency was to lose sight of border-line cases. From this standpoint people fell definitely into two classes: the sane and the mentally diseased. The concept of prophylaxis became narrowed to include only the means of avoiding outright insanity. Even this kind of prophylaxis, according to the fatalistic views which prevailed until recently regarding all mental disorders, had little room for influence.

Although a pathological basis has been determined for certain forms of mental disorder, it is a matter of the greatest educational significance that for some insanities and for most of the minor disturbances of mental function no underlying nervous pathology has been established. Such defects are coming to be looked upon as purely functional, by which is meant that they are the result of unfortunate emotional experiences, unhealthy associations of ideas, defective will-training, etc.

Especially significant is the fact that the roots of most functional mental disorders have been traced back into the period of childhood. An initial mental deviation of slight extent may lead ultimately to insanity, hysteria, crime, suicide, or a life of wretched discontent and inefficiency. The balance and sanity of the adult are largely predetermined in the years of childhood.

From the functional point of view, preventive mental hygiene thus becomes as broad as education itself. It becomes the duty of those charged with the education of the young to recognize the dangers incident to mental development, to identify the child of neuropathic tendency, and to throw about him the influences of training and environment which will direct him into the paths of normal thought and behavior. It is necessary, therefore, to pass in review the most common symptoms by which the neurotic constitution may be recognized.

Symptoms of nervous disorders

It is understood, of course, that not all the symptoms enumerated in the following pages are found in any single case. Nervousness, as some one has said, is not one disorder, but a whole cohort. It may assume any one of many forms, and the symptoms will vary accordingly. The symptoms listed here include nearly all of those commonly seen in neurotic persons.

On the physical side the nervous child is likely to be restless, to lack inhibitory power, to be easily startled or shocked, and to suffer from muscular twitches or automatisms. Often there is a lack of control of the accessory muscles, with stuttering, overmobility of the facial muscles, nervous fingering of objects, etc. The features may be tense, the step hurried and clumsy, the grasp insecure. Pencils, books, and papers are dropped, the feet are shuffled, and the like. The child becomes the despair of the teacher. When the arms are raised in the forward position the fingers either tremble or extend themselves with tense rigidity. Incoördinations may be present, so that, for example, the child cannot walk with a book balanced on the head. Indigestion is common, together with anæmia, deficient or freaky appetite, etc. Often the heartbeat is irregular or excitable. The eye accommodation may fatigue easily, causing the print to blur. Headaches are common.

The most significant symptoms, however, are the emotional and volitional. The nervous child is apt to be unstable in its emotional life, easily turned from laughter to tears, quick to anger, irritable, peevish, etc. There is constant hunger for excitement, and distraction is sought in variety of stimulation. The child is not happy without an array of playthings or occupations. Numberless idiosyncrasies may develop, involving habits of play, work, dress, eating, etc. The eccentric child is always a nervous child. Sleep is usually affected. The child has difficulty in getting to sleep, has to be tucked in several times, wakes easily, has night terrors, gets up peevish, etc.

The life of the nervous child is often made wretched by haunting fears, — fear of the dark, of burglars, of impossible animals, of death, hell, the loss of father or mother, etc. Sometimes the fear is not specific, but is evident as a vague "anxiety state" which makes the child forever apprehensive. Nervous children are usually oversensitive to the opinion of others, unable to endure blame, and constantly hungry for praise. Severity shatters them, but for the sake of approval or to surpass others they will work to the point of exhaustion. The sexual emotions may be prematurely or abnormally developed.[1]

Normal conduct, conceived as the suitable adaptation to concrete environment, involves the highest of human powers, and is the first to suffer when the nervous controls are weakened. The nervous child is hesitating, timid, vacillating, unable to cope with the real. More and more he falls back upon day-dreams, books, imaginative enjoyments, etc. He plays little, adjusts badly to other personalities, is seldom a leader. Not infrequently he is made an outcast by his fellow-pupils. Not being able either to mingle on equal terms

[1] While most nervous children show the type of symptoms given above, certain ones, on the other hand, are apathetic, listless, and indifferent. These limp, over-quiet, under-tense, and nervously deficient children are apt to be overlooked because they are facile and docile.

with other children or to depend on himself, he clings to adults and becomes oldish and precocious.

The feeling of weakness, distrust of self, low resistance to fatigue, inability to work under pressure, difficulty in deciding what to do next, are other volitional symptoms of the neurotic constitution. Work is allowed to drag along unfinished and appointments are not promptly met. Neurotics easily acquire the habit of tardiness.

Absurd scruples, religiosity, or over-conscientiousness may appear. The child weeps from stepping on ants, considers it sinful to eat meat, suffers torments over imaginary sins, etc. There may be a foolish abhorrence of dirt, so that the hands must be washed dozens of times a day. Sometimes the scruples concern dress, manners, eating, excretory processes, etc.

From what has already been said, it is clear that the moral life is also involved, for morality is nothing but the appropriate issue of thought and emotion in conduct. The most common moral faults of nervous children are lack of self-control, outbreaks of temper, incorrigibility, stubbornness, sulking, egotism, lying, kleptomania, personal vices, etc.; in short, the faults that go with feelings of weakness and incapacity.

The outbreaks are not so much due to the overpowering strength of impulses as to the weakening of controls. Abnormal stubbornness, contrary to common opinion, does not indicate strength of will, but weakness and faulty adaptation. Lying is often a defense neurosis. The undue persistence (i.e., beyond ten or twelve years) of the normal childish tendency to boastful, imaginative lies is distinctly pathological, and not infrequently masks a feeling of weakness, incapacity, inferiority, etc. Sometimes it is a mere symptom of abnormal egotism. Kleptomania is often an obsession, a fixed idea, involving the collecting instinct. The most common moral faults of the neurotic, however, are instability, unreliability, and weakness.

Symptoms relating to intelligence are not as numerous or characteristic as the emotional and volitional symptoms. Nervous children are fully as likely to be bright as dull, but their intelligence is seldom of the most practical sort. The imagination is likely to be overactive. There is often an abnormal preoccupation with books, language, and abstractions as contrasted with things. These traits give the impression of mental precocity. The child is hailed as a prodigy, paraded as a genius, etc., with unfortunate consequences for his later development. Some of the wonder-children are stupid in everything except their exhibition specialties.

One-sided development is favored in the neurotic child because of the difficulty of giving voluntary, or forced, attention. Mental association takes the path of least resistance. Extraordinary accumulations of information alternate with gaps of profound ignorance. Day-dreaming and intellectual indolence take the place of determined attack upon the varied intellectual problems set by the school or environment. Periods of intense intellectual activity may occasionally supervene, followed by slumps that may be characterized as "twilight states." Comprehension is uneven.

Suggestibility, often, is abnormal. The child imitates the peculiar gestures of those he admires. Stuttering and even choreiform movements are sometimes initiated in this way. The organization of their ideas may be unduly influenced by accidental stresses. Instability characterizes the intellectual as well as the emotional and volitional life. The neurotic child is the creature of his environment.[1]

The picture may be made more clear by the following description of a concrete case: —

Girl, aged 7. Weight and height normal for age. Bright and highly imaginative. Two years advanced in school. Speech, blustering, with hasty and indistinct articulation which months of daily drill failed to improve. Finical in her habits. Has an unconquerable preference for stimulating and highly seasoned foods, pickles, salt, spices, cakes, coffee, hot soups, etc. Seldom eats the more wholesome articles of food except under compulsion. Almost from babyhood has had an abnormal interest in dress. Plans for weeks ahead the apparel for set occasions. Absurdly preoccupied with ceremonies and symbolisms relating to birthday, Christmas, Easter, etc. All such occasions are planned for in the minutest detail. Her life is pathologically subjective and introspective. Volatile, cries at slightest censure, fishes for praise. Is oversensitive to the good will of the teacher and overworks at school from emulation. Over-affectionate, yet imperious and hard to manage. Unreliable, "forgets" promises. Sleeps poorly, has nightmares, wakes easily and cannot get to sleep again for hours. Obsessive fears make her miserable as night approaches. She cannot go to sleep

[1] See *Hysteria*.

without a light in the room and some one beside the bed. The bed must be against the wall, the doors shut and locked, etc. She is tormented with religious and moral scruples. Worries if prayers are forgotten, and cannot bear the thought of missing Sunday School. Suffers from headaches, anæmia, and constipation. Gestures are awkward and exaggerated. Always fingering objects. Fumbles and drops things.

Suggestions for observation [1]

I. Disturbances of motor-control.
  - Overmobility of facial muscles.
  - Twitching of eyelids, face, or fingers. (Test control of fingers by having children close the eyes and sit with hands extended, palms down, on the desk.)
  - Spasmodic movements of any kind.
  - Bad coördination. (See if child can walk with book balanced on the head.)
  - Drops objects frequently from the hands.
  - Jerky handwriting.
  - Inability to sit still. (Ask children to sit still for five minutes.)
  - Stuttering.
  - Blustering, rapid speech.
  - Nail-biting, chewing pencil, fumbling a button, etc.
  - Bed-wetting.
  - Frequent requests to go out.

II. Emotional and moral disturbances.
  - Irritability or bad temper.
  - Laughs or cries at slight cause.
  - Undue emotion of any sort.
  - Extreme suggestibility.
  - Excessive timidity or embarrassment.

[1] The writer is here indebted to Cornell's *Health and Medical Inspection of School Children*, pp. 333–34, and to Dr. E. B. Hoag.

Misbehavior.
Sex perversions.
Perverted tastes.
Moroseness, sullenness, or obstinacy.
Over-affectionateness.
Undue sensitiveness to praise or blame.
Over-conscientiousness.
Religiosity.
Day-dreaming.
Lying or stealing (if moral environment is good).
Cruelty.
Finical habits.
Eccentricity or "queerness."
Child an "outcast" among his fellows.
Sleep disturbed (nightmares, tooth-grinding, sleep-walking, etc.).
Morbid fears.
Chronic uneasiness or apprehension.

III. Indications of nervous exhaustion.
Apathy.
Dull eyes.
Drooping shoulders.
Slouching postures.
Shuffling gait.
Arms and hands droop when extended forward.

IV. Associated physical conditions.
Adenoids.
Eye-strain.
Headaches.
Faintness or dizziness.
High fatiguability.
Poor nutrition.

CHAPTER XVII

PREVENTIVE MENTAL HYGIENE

II. COMMON NEUROSES OF DEVELOPMENT

Psychasthenia

Accepting Janet's conception of psychasthenia, we may define the condition as one of chronic uneasiness and disquiet, with feelings of incompleteness. Obsessions, impulsions, lack of certitude, anxiety, timidity, longing for moral support and comfort, meekness, indecision, etc., are the most common symptoms. If extreme fatiguability is present as one of the main symptoms the condition is known as neurasthenia.[1] The symptoms may include any or all of the long list given in the preceding pages as characteristic of the neurotic constitution. Visceral disturbances, disorders

[1] Psychasthenia and neurasthenia are variously defined by different authors. Janet states that they are "two manifestations of different degree and gravity," of which "neurasthenia is the initial form." Neurasthenia, says Janet, is essentially "an organic enfeeblement" marked by bodily symptoms, such as weakness, trembling, digestive troubles, and the like. Visceral disturbances are especially common. In psychasthenia the disturbances present themselves more especially in the conscious mental life. "Psychasthenia is a depressive psycho-neurosis characterized by diminution of the functions which permit us to act on reality and to perceive the real, by the substitution of mental operations that are inferior and exaggerated, under the form of doubts, of agitations, and of anxieties, and by obsessive ideas which express the preceding troubles and which themselves express the same character." (*Les Obsessions et la Psychasthenie*, vol. I, pp. 754–55.)

of nutrition, headaches, insomnia, constipation, vertigo, muscular weakness, etc., are a few of the many symptoms likely to be associated with it.

Psychasthenia is common among adults, but is seldom met with among children. A considerable proportion of teachers are affected, probably 3 to 5 per cent. According to Ballet (1) it is most common among business men, teachers, and students, and least among laboring men, the clergy, farmers, and physicians. More women than men are subject to it.

Until recently medical authorities endeavored to explain psychasthenia in terms of physical causation, such as chronic exhaustion of the central nervous system due to overwork, or a condition of auto-intoxication resulting from infectious diseases, glandular disorders, etc. Adolescent overpressure was thought to play a great part.

It is now generally believed that psychasthenia may be of functional origin, a result of the interplay between a somewhat unstable heredity and certain elements of an unsuitable training. Over-repression is one of these. The functional view is supported by the fact that a psychoanalytic search for the causes, followed by reëducation of the patient along the lines of his mental faults, often brings a cure. The methods of Christian Science, Yoja practice, etc., sometimes accomplish this result in an unscientific way; the trained psychiatrist succeeds through his knowledge of underlying psychological principles.

From the functional point of view, childhood is the critical period for those of psychasthenic tendency. A training which inculcates over-conscientiousness and scrupulosity, which destroys self-confidence and initiative, or fails to develop a rich fund of healthful, objective interests, lays the foundation for the pathological timidity, indecision, weakness, anxieties, and morbid fears characteristic of psychasthenia. Interesting illustrative cases are described by Dr. Williams (60).

(1) A boy, reproved severely by his puritanical parents for jealousy of his little brother, developed chronic mental distress, the mania for touching things (*délire de toucher*), and was a slave to the apparently absurd impulse to lie down on his back several times when putting on his clothes. Investigation brought out the fact that these were childish devices for expiation for the sin of jealousy.

(2) A girl of eight years was brought to Dr. Williams because of involuntary facial grimaces and foolish gestures, such as touching the floor before she stepped on it. The girl had been severely trained, particularly along the line of avoiding injury to others. Questioning revealed that the child had worried for fear her expired breath, which she had been taught was poisonous, might do injury to others. The facial grimaces were discovered to be kissing movements, since, from her childish way of thinking, kissing each breath of expired air would "make it well." The touching of wood, likewise, was the "healing touch" that would keep it from being hurt by her tread.

(3) Affectionate girl with parents of cold, nagging disposition, who did not permit in her any show of affection. The child developed insomnia, headache, dizziness, habits of crying, etc. Reform of the parents brought relief to the child.

Williams concludes that the moral sanctions suitable for adults may be decidedly injurious to children. Coupled with puritanical over-repression, they tend to develop obsessions and anxieties, the mania to compensate, to expiate, to make contracts with Fate, etc.

Let us avoid moral over-pressure by not taking the faults of the child too seriously and by holding him to a standard of conduct commensurable with his immaturity.

Hysteria

Hysteria is essentially an enfeeblement of mental control, of the synthesizing, organizing, and directive powers of the mind. This lowering of what Janet calls the "psychic tension" permits emotional shock or strain to start dissociation, or mental cleavage. Certain thought-systems drop out of consciousness, or are banished because of their disagreeable emotional tone. Queer and inefficient "substitutions" then take the place of the lost thought-systems, the substitutions being themselves the symptoms of the disorder.

The symptoms are marked by abnormal suggestibility, dominance of automatisms, dreamy states, etc., and may include all sorts of motor and sensory disturbances, such as convulsions, tremors, paralyses, vasomotor and secretory disorders, anæsthesias, hyperæsthesias (under-sensitivity and over-sensitivity), etc. Pin-pricks in certain localities may not be felt. The visual field may be retracted in one or both eyes, and numerous other symptoms of similar nature may appear without any real physical disability underlying them. The disorder is purely functional.

True hysteria does not often develop earlier than 15 to 18 years, but authorities are agreed that the mental conditions which lead to the hysterical manifestations have their origin in the first fifteen years of life. Hysteria is always predetermined in the school period or in the period immediately preceding school life.

The characteristic trait of those hysterically inclined is abnormal suggestibility, together with emotional instability. The "railroad-wreck" spine illustrates very well the mental mechanism of one form of hysteria. A young woman is thrown from her seat in a collision of trains. She is picked up unable to walk and carried to the hospital. Although the most careful diagnosis, including the radiograph,[1] reveals no injury whatever to spine or hips, the patient may remain for months in a paralyzed or semi-paralyzed condition. There may be no conscious intent to deceive or simulate in order to secure damages, get sympathy, etc.; the case is due entirely to suggestion. Chorea, deafness, speech defects, asthma, and many other disorders are sometimes of hysterical origin. It is, therefore, always a problem to distinguish true chorea, real organic deafness, etc., from their hysterical simulations.

School epidemics of various kinds of psychical contagion have their origin in the hysterical predisposition. Of several such epidemics described in the interesting study of Dr. Burnham (4) one or two may be quoted here.

[1] X-ray pictures.

(1) The Liegnitz epidemic.

One of the earliest reported epidemics of this kind occurred in Gross-tinz, near Liegnitz, Germany, in 1892. The first case appeared on the 28th of June, when a ten-year-old girl, without apparent occasion, began all at once to tremble in her right hand and then gradually in the whole body, a condition which passed off in about half an hour without any further results. On the next day the trembling appeared in several other girls, and lasted from half an hour to an hour. Not the children sitting next, but those several seats away, were affected. The trembling returned regularly each day and began to last longer and longer, and the school instruction soon suffered because the girls who were attacked could not write. One day, at the beginning of July, one of the trembling girls was attacked with convulsions and fell under the seat. Although the teacher immediately removed this child from the class, several new cases of convulsions soon appeared among the healthy girls, and on the 19th of July the number of victims was twenty. During the period from the 14th to the 20th of July, the instruction was equally exciting for both teacher and pupils, and presented a noteworthy picture to the medical observer. On almost every seat were patients having convulsions of the whole body. The girls fell under the seats and had to be carried from the room by the boys, and the attacks continued for different periods of time between a quarter of an hour and an hour, when they gradually ceased. After the autumn vacation the attacks ceased and no fresh cases were reported.

(2) In October, 1905, a thirteen-year-old girl in Meissen was attacked with a tremor or shaking of the hands. Soon other cases appeared, and although it was hoped that the trouble would disappear during the Christmas vacation, this did not happen, but in January and February the disease became epidemic, and by the 21st of February, 134 children were afflicted. The classes were then closed until the 14th of

March, and the parents were given advice in regard to the treatment of the children. In spite of this, the number increased. On the 20th of March, 237 children were suffering from the disorder. Then the number began to decrease, and on the 29th of March there were only 196 afflicted, and by the 17th of May the epidemic seems to have been at an end.

The disease was caused by seeing a child who had it; and children from all classes, strong and weak, were attacked, especially the girls. The causal factor must have been psychic infection.[1]

Children should never be punished or blamed for such hysterical symptoms, nor should their attention be needlessly directed toward their disorder. There may be no conscious pretension on the child's part. The special class has been used to advantage in such epidemics to prevent the spread of the contagion, and soon brings about a cure of those already afflicted. The Basel special class of 1904, organized for this purpose, went on with the regular school work, and by means of suggestive treatment applied in the form of simple gymnastic exercises, warm lunches, etc., all the cases were speedily cured.

Real hysteria is not extremely common, but the emotional instability and the hyper-suggestibility bordering on hysteria are not uncommon. To fixate the child's attention too intently upon matters of health, to over-stimulate the precocious, to permit day-dreaming to take the place of productive work, to destroy in any way the feeling of self-reliance and per-

[1] Epidemics of hysteria are of course extremely rare. They are instructive, however, because they illustrate the possible force of that psychic contagion which in milder form is known to every one.

sonal independence, all help in the formation of characters that may become hysterical. To enter into the "league of silence" regarding sexual matters and to conceal from the child the knowledge of sex demanded by a normal curiosity leads to the acquisition of all kinds of false notions and to "modes of repressions and concealments of emotional states which may become the nuclei for hysterical manifestations in later life" (13).

Dementia præcox

Dementia præcox is one of the most interesting forms of insanity for several reasons. In the first place, it is extremely common, accounting for some 30 per cent of the total admissions to insane hospitals. In the second place, it does not attack the old or mentally decrepit, but the youth, and quite frequently the youth of marked intellectual promise. In the third place, the newer studies of the disease show that it is probably due in most cases to definite, ascertainable functional disturbances of the individual's mental evolution, and that, if taken in hand early enough, it will yield to the right kind of educational treatment. In the fourth place, the methods which have been successfully used in its prevention and treatment throw a flood of light on preventive mental hygiene in general. The lesson it teaches forms a contribution of real value to the problem of education for efficient living.

Dementia præcox is a form of adolescent insanity which usually involves fantastic day-dreaming, sexual imagination, brooding over disappointments, and (the most central symptom) a discrepancy between thought and action. As described by Jelliffe (26), it is most likely to develop in those "who are abnormally brilliant, but whose lights are turned inward." The patient may be gentle in disposition; of dreamy, lofty, exclusive, disdainful demeanor; conceited, egotistic, given to deep ruminations, and always unpractical. "There is a glorification of vague abstractions" coupled with "a constitutional aversion to deeds." As characterized by Dr. Meyer (40), it is essentially "a miscarriage of instincts through lack of balance"; a deterioration of habits "due to progressively faulty modes of behavior and action"; "a covering-up rather than a correction of harmful yearnings." In the classical description of Dr. Meyer, "There develops an insidious tendency to substitute for an efficient way of meeting difficulties a superficial, moralizing self-deception, and an uncanny drift into many varieties of shallow mysticism and metaphysical ponderings or into fantastic ideas which cannot possibly be put to the test of action. All this is at the expense of really fruitful activity, which tends to appear insignificant to the patient in comparison with what he regards as far loftier achievements. Thus there develops an ever-widening cleavage between mere thought-life and the life of actual application, such as would bring with it the corrections found in concrete experience. Then, under some strain which a normal person would be prepared for, a sufficiently weakened and sensitive individual will react with manifestations which constitute the disorders of the so-called 'deterioration process,' or dementia præcox. Unfinished or chronically sub-efficient action, a life apart from the wholesome influence of companionship and concrete test, and finally a progressive incongruity in meeting the inevitably complex demands of the higher instincts — this is practically the formula for the deterioration process."

The following are clinical descriptions of typical cases, the first from Dr. Meyer, the second from Dr. Hoch: —

(1) She began school at seven years, was smart, and applied herself well, but at the age of eleven she seemed to be failing, and was thought to be studying too hard. She grew thin, seemed nervous, and complained of headaches; at twelve she was in poor health. . . . [Later] She was disappointed at home, for some time dreamt of becoming a teacher, but soon sank into hypochondriacal ruminations, and finally, at twenty-one, after useless surgical operations, passed into a confused religious excitement, followed by stupor, in which she sits inactive and irresponsive, with the top-heavy and yet empty notion of being good, of saving the world, etc.

(2) The patient is said to have been retiring, modest, shy; had to be driven to play. The parents say that the other child they have is aggressive, while the patient is not; that the other looked out for herself, while the patient relied on others. She was always afraid she had not done things right. . . . When thirteen, she became inactive, lost interest, became dissatisfied with things, got rattled at school and could not do her work. Then followed vague talk about deep subjects, such as "Why does the universe exist?" and so on. By fifteen she was gravely deteriorated.

The next few decades may witness the complete demonstration that such cases can usually be saved by being taken early in hand and trained to more complete activity and appropriate self-objectification.

But, as already indicated, the importance of this principle of the sanifying influence of wholesome activity does not lie merely in the insurance it offers against insanity. Inasmuch as sanity is purely a relative term, the importance of activity and self-objectification goes far beyond its prophylactic value as an insurance against admission to an insane hospital. In a sense no one is perfectly sane. Just as there are millions of physically inefficient persons who are in no immediate danger of death, and relatively few who are perfect of body, so there are numberless people who are in no danger of trial for lunacy, but who, nevertheless, are decidedly below their best level of mental balance. Dementia præcox has been mentioned at length only because it reveals, writ large, that which to a less degree is true of most of us. The causes which produce complete deterioration in the individual of nervous instability may, in the person of better hereditary endowment, result in nothing more serious than a temporary nervous breakdown, "a slump of relative inactivity," or some other manifestation tending to rob life of its zest and render success more difficult.

In order to escape such dangers, children need to be taught to " avail themselves of the power of the concrete." School work should feed the instinct of workmanship instead of starving it. As Meyer states it, "If the school gave more opportunity for doing things, dreams of doing would be less tempting." It behooves us "to make doing just as attractive as knowing," and to explore ways and means of enlarging the child's opportunities for the accomplishment of simple, wholesome, and enjoyable things. Plays and games which demand quick decision and self-reliance are indispensable to a well-balanced mental development. Good players seldom become "queer" or socially inefficient. We must find for each child the level where he can function successfully if we would have him escape the shocks of disappointment, the habits of failure, and the resulting inactivity, day-dreaming, vain wishing, and the chasm between thinking and doing. If we will only take pains to fit the tasks to the capacity, every child can be taught to do certain things well and to take pleasure in doing them. Nothing is more subversive of sanity than a régime of inactivity and repression which creates a smouldering volcano of sentiment and frothy desire.

Chorea (St. Vitus's dance)

In a majority of cases chorea is associated with rheumatic affections of the joints, "growing-pains," etc., though in all probability it presupposes also the neurotic constitution. The onset often seems to be occasioned by overwork, excitement, shock, and the like, and it is certain that, notwithstanding the connection with rheumatism, a certain proportion of cases could be prevented by suitable mental hygiene. Rheumatic symptoms in children not characterized by nervous instability are not, as a rule, followed by chorea.

Chorea is by no means an uncommon disease, affecting probably about one child out of a hundred sometime during the school life. It seldom appears before the age of 6 and not often after 14. Of 2000 cases analyzed by Starr 45 per cent began between 6 and 10, 38 per cent between 11 and 15. It occurs more often in the spring months. Girls are affected much more often than boys, according to Still (48), in the ratio of about 5 to 2. The choreic child is usually bright, often precocious and of excitable temperament — exactly the child who is most likely to be spurred on to rapid school progress and who is most likely to be injured by it.

The duration of the disease is usually from six weeks to three months, though a few cases drag on with little change for years. Because of the connection with rheumatism the heart is very likely to be affected. Dr. Still found heart symptoms in 155 out of 250 cases. Many adults who suffer from organic heart disease are merely victims of a neglected rheumatic infection during childhood. On account of the danger of heart involvement, as well as for the needed mental rest, it is very important that chorea be diagnosed in its earliest stages, and that the child be taken from school at once and put to bed. Absolute rest in bed is always advisable for a period of from three to six weeks, and school work should not be taken up for several months. Recurrences are very common, especially in the spring months, and all authorities are agreed that nothing is so likely to determine a fresh attack as the too early return to school. An additional reason for keeping the child out of school until all symptoms have disappeared is the danger of psychic contagion. Veritable school epidemics of chorea have been recorded.

Every teacher, therefore, should know the symptoms of beginning chorea. The disease generally appears so gradually that the child is likely, to its great injury, to be allowed to continue in school for two or three weeks, or longer, after it has begun to develop.

At first the child may be considered unusually nervous. It drops things, has difficulty in sitting still, is clumsy in eating or buttoning the clothes, has an awkward, shuffling, unsteady gait, and stumbles. Sometimes the first symptoms are slight spasms of the facial muscles, twitching of the eye, grimaces, and the like. Later the movements become intensified, irregular, jerking, and almost constant except during sleep. In severe cases speech is almost impossible, and the child may be practically unable to walk or to handle fork or spoon in eating. The mental symptoms of chorea are often almost as characteristic as the physical. The child is irritable, emotional, capricious, inclined to worry, sleeps badly, has nightmares, headaches, and a poor appetite. Blood examinations nearly always show profound disturbances of nutrition.[1]

When fully developed, the disease is not easily mistaken for any other nervous affection except habit-

1 The rheumatic infection is thought to bring about the rapid destruction of red blood corpuscles.

spasm, and this distinction may usually be made without difficulty if it is remembered that habit-spasm is always quite definitely located in certain muscles, while the movements of chorea are irregular and more generally distributed. You can describe the movements of habit-spasm, get a definite picture of them, but you can seldom tell what twitchings or grimaces the choreic child will perform next.

It is the early symptoms especially with which the teacher should try to familiarize herself, the slight awkwardness, twitchings, unrest, peevishness, excitability, thickness of the tongue, etc. As a rule the child is scolded or punished at home and at school for a week or two after the disease is under headway. It is useless to expect the average parent to make the diagnosis in the early stages, but teachers with their larger opportunities for observing children may learn to do so if they are at all observant.

Tics, habit-spasms, etc.

These are forms of spasmodic movements which shade into one another and are sometimes difficult to differentiate from chorea. Tics and habit-spasms involve an isolated twitching or contraction of any muscle or muscle-group, as of the face, tongue, neck, or organs of respiration, such as elevating the lip to meet the nose, sniffling, lightning-like blinks or nods, writhing, shrugging the shoulders, elevating the chin and stretching the neck, protruding the tongue, showing the teeth, emitting queer guttural noises, etc. The movements may be confined to one muscle, or muscle-group, or there may be a whole repertoire of foolish-looking grimaces. One week the tongue may be chiefly concerned, next week the lips or eyebrows.

The movements are automatic and involuntary. By extreme effort of will they may be suppressed for a little while, but are sure to reappear as soon as effort is relaxed; or if the tic is conquered in one location, it reappears elsewhere. To punish, nag, or scold children for their habit-spasms is sheer cruelty. As well combat stuttering with the rod. The defect is always aggravated by unsympathetic treatment. Rewards and praise for successful control are much more efficacious. Daily practice in self-control before a mirror, motor exercises involving arms, neck, muscles of respiration, etc., have been used to advantage.

But tics, habit-spasms, etc., are now believed to be usually of psychical origin. Anæmia, over-pressure, and reflex irritations, such as intestinal parasites, defective teeth, a sore on the face, etc., may be the occasion of their appearance, but are seldom, if ever, the true cause. They are more often associated with emotional repression, obsessions, phobias, and other evidences of functional instability, and, as Williams has shown, are usually curable by suggestion and the methods of psycho-analysis. Sometimes they disappear of themselves, especially if the child is not punished or scolded. In other cases, if not properly treated, they become fixed by habit almost beyond eradication. Strong emotion, worry, and overwork aggravate them.

Here, as everywhere else, prevention is better than cure, and much easier. Marked and intractable cases should be taken from school because of the danger of psychical contagion.

Nervous automatisms differ from tics and habit-spasms in being less spasmodic and less confined to particular muscles. All sorts of aimless movements are included here, such as shuffling the feet, fingering pencil, button, the hair, etc., pulling at the ear, rubbing the nose, biting the lips or nails, stretching the fingers, tapping, turning, thumping the knees, and the like. To a greater or less degree automatisms are almost universal, and unless excessive need not occasion concern. Lindley (32) found that the "accessory" muscles are more often involved than the "fundamental," particularly in the upper grades; that there is little difference between the sexes; that they are greatly increased by intense mental effort; and that they are especially characteristic of fatigue states. Automatisms indicate defective control rather than excess of energy, and are aggravated by the school's repression of "fundamental" movements. The important point for the teacher to understand is that the nervous restlessness of the child who never sits still is not due to willfulness. It is better to send such a child out to play, or to think up some errand for him to do, than to nag or punish. If the restlessness is chronic and extreme, thorough medical examination should be secured.

Epileptic school children

True epilepsy is probably always due to some hereditary defect of the central nervous system, and is seldom curable. Usually, though not always, it involves progressive mental deterioration leading to a marked degree of feeble-mindedness. Tests of several hundred epileptic children at the New Jersey Epileptic Village at Skillman (56) showed an average mental retardation of three to four years at the age of 10 or 11, increasing to seven or eight years by the age of 15. Such cases really belong in separate schools or institutions where they can have the medical supervision and the special educational treatment suited to their needs. If the fits are of such a character, or if they occur at such times, as to disturb the work of the school, the epileptic child should under no circumstances be permitted to attend classes with normal children.

Some cases of what appears to be epilepsy are due to bodily disturbances, such as auto-intoxications, eye-strain, decayed teeth, intestinal parasites, nasal growths, etc.

There is a mental equivalent of epilepsy, so-called "psychic epilepsy," the nature of which all teachers should be acquainted with. Psychic epilepsy is a kind of mental explosion, "brain-storm," during which the patient may make an attack or do and say all sorts of unaccustomed things. The period may last from a few minutes to several hours, and is followed by a normal state in which the patient remembers little or nothing of his unusual acts. Swift (51) cites the case of a school girl eight years old who, "while standing in line with her classmates, suddenly broke away from the others and ran around in a circle three or four times, then looked confused, giggled a little, and became quiet. When reprimanded by the teacher she insisted that she did not know what had happened." In this case the attacks became frequent and were succeeded by true epileptic seizures.

Dr. Healy, who has for several years been engaged in a psychological and medical study of juvenile offenders in the Psychopathic Institute connected with the juvenile courts of Chicago, found that more than 7 per cent of 700 third-time offenders were victims of psychic epilepsy. Sometime, perhaps, we shall know enough to substitute medical care and education in place of the punishment usually meted out to such unfortunates. Likewise the teacher would do well to take a sympathetic attitude toward the school child, by no means rare, who is subject to sudden explosions of anger or irritability. The following instance came under the observation of the writer: —

Boy of 14, mentally retarded (in the third grade), usually good-natured and quite inoffensive, became enraged one day at school over some trifling incident and struck one of the older girls senseless. The teacher, a man, considered the act as purely volitional, and beat the boy unmercifully.

CHAPTER XVIII

PREVENTIVE MENTAL HYGIENE

III. THE EDUCATION OF NERVOUS CHILDREN

MOST authorities on mental diseases believe that the appearance of any severe neurosis (other than a certain few due to infectious diseases or toxins causing definite anatomical lesions) always denotes an inherent psychopathic tendency in the subject. Even granting this, however, we are not forced to take the fatalistic point of view. The unfavorable heredity is, after all, only the inheritance of a tendency. Whether the evil made possible by heredity materializes probably depends in a majority of cases upon what we may call accidental factors of environment.

The accidental factors may be divided into two groups: (1) Preventable physical abnormalities which favor the development of nervous conditions. Among these are adenoids, eye-strain, intestinal worms, malnutrition, impacted or decaying teeth, the toxins resulting from overwork or the incomplete elimination of body wastes, lack of exercise, fresh air, sleep, etc. (2) Faulty education, particularly of the emotional and volitional functions.

The necessity of attending to the factors named in the first group is admitted in all schemes of psychoprophylaxis, while the importance of the pedagogical factor is almost as universally neglected.

Faulty education as related to nervous disorders

Nevertheless, modern researches in functional psychopathology are constantly making it evident that the misery suffered by neurotics is due very largely to faulty education, using this term in the broadest sense. "Alas," said Goethe, in *Wilhelm Meister*, "how much there is in education, in our social institutions, to prepare us and our children for insanity."

In our classification of people as nervous, weak, balanced, self-confident, selfish, magnanimous, etc., we tend to lose sight of the conditions and experiences which have made them so. Most of us look upon imperfections as intentional products of a perverted will, forgetting that the will itself, even character, is but the composite resultant of an infinite number of individual acts and experiences. Nothing happens in mental cosmogony, not even the perverted will. What we are going to think or do, how we are going to feel, depends upon what we have thought, done, and felt. Character is "an epitome of the past and a forecast of the future" (46). The only reason things seem to happen in mentation is that many of the connecting links are hidden below the threshold of consciousness. The study of the subconscious, however, has at last succeeded in bringing to light submerged, associative elements which explain many of these apparent happenings. Law and order are thus taking the place of what before was psychological chaos.

Suppressed feelings

In the most literal sense, everything that is experienced is conserved. Not that it can be recalled, any moment, by an act of the will; but conserved in the sense that it will remain functionally active as a determiner of future mentation. Thus Freud demonstrates that when in childhood a disagreeable emotion is suppressed, carrying with it into apparent oblivion a host of associated memories, the disagreeable emotion and its suppressed associates are by no means annihilated, but may reappear in adult life as phobias, obsessions, hysteria, etc., whose origin is not suspected by the patient and can only be brought to light by the methods of psycho-analysis.[1]

Nervous states, therefore, if we can accept the functional explanation of the Freudians, may have as their basis unassimilable experiences, experiences which because of their painful feeling tone have been suppressed as by a mental censorship.

But suppression, as already indicated, is not equivalent to annihilation. The suppressed elements remain as "disturbers of the peace," giving rise to inner mental conflicts, to anxieties, stuttering, obsessions, hysterical symptoms, and the like. During sleep, when the faculty of censorship is weakest, they obtrude themselves in the form of night terrors, dreams involving

[1] For an exposition and criticism of psycho-analysis see the article by Harry W. Chase, "Psycho-Analysis and the Unconscious," *Pedagogical Seminary*, vol. XVII, pp. 281–327. Also other references at the close of this chapter, especially reference 3.

wish fulfillment, etc. Even in waking life they may exert a constant pull sufficiently strong to determine the direction which life activities shall take. It is a wise man who knows the real sources of his likes, his aversions, his ideals, and his prejudices.

The puritanical suppression of the play instinct and of the spirit of adventure in the young may rid us of certain troublesome pranks and inconveniences, but we are coming to believe that it creates a harvest of vice, crime, and neuroses. Whatever else play may mean, Aristotle's conception of it as a catharsis is essentially correct. The child whose conduct is molded too closely by adult moral standards, whose devilish spirit of adventure is denied all the customary outlets, is likely some day to overflow with the accumulated "cussedness" of years. Mental hygiene demands that the larks and pranks of boyhood be not too severely frowned upon.

Prevention of morbid fears

There is danger in all forms of mental irreconciliations which lead to suppression. The condition resulting is one of imperfect mental unity, or in extreme cases even double personality. Conflicts arise, entailing fears, the feeling of inadequacy, etc. An important function of education, as Plato observed, is to teach children to fear aright, which means to free them from the fears that are unreasonable, imaginary, or the outgrowth of weakness. Fear is the evil genius of most nervous people. The fear of insomnia keeps them awake; the fear of exhaustion induces in them the chronic feeling of fatigue; the fear of not succeeding makes hopeless failures of them; the fear of their own impulses makes them slaves of each momentary whim. Over-conscientiousness, which comes as a rule from self-distrust, does not betoken moral strength, but self-distrust, and is a poor guaranty of right conduct. "Keyed-up prepossessedness," sometimes seen in one who sets about doing something with all his might, has in it an element of fear and has been experimentally proved to be unfavorable to success.[1] The school should assist parents to "discover and to remove the overgrowths of fear" which attach themselves parasitically to the lives of so many children, and to prevent the development of irrational fears, prejudices, and aversions.

There is danger, however, that the extreme applications made of this principle by Christian Scientists will blind us to its essential truth. The best way to combat fear is by reason and by the gradual habituation to courageous acts. Once convince a man that two hours of sleep, more or less, will not matter much, he will cease to fear insomnia and will sleep. If the child fears the dark, let him become accustomed, little by little, to venturing alone in the dark, and each successful venture will add to his courage: only it is necessary to go slowly to avoid shock. Once thoroughly convince the stutterer, by speech drills or otherwise,

[1] See W. F. Book: *The Psychology of Skill, with Special Reference to Typewriting*. 1908, pp. 136 *ff*.

that it is possible for him to speak without tripping, and he is placed well on the way to recovery. By a little experience of success, appropriately arranged for by a thoughtful teacher or parent, the child who is diffident and distrustful of his powers is released from his paralysis of will and inspired with confidence.

Even when the difficulties which beset the fearful and timid are not wholly imaginary, the patients can be taught to face them honestly and to make the best of a bad situation. The neurasthenic has been fitly described as "the person who runs away from a difficulty into the refuge of a nervous breakdown." It is especially destructive of mental integrity for the child to be always shielded from the consequences of his own acts; whence the sanifying influence of plays and games in which error brings its certain penalty and skill its quick reward. By a scheme of treatment thoroughly enough reversed from its true order the bravest child may be made into a coward. Conversely, the most timid may be made to tingle with confidence and courage.

The value of social experience

Social experience is an indispensable corrective for the introspective tendencies of nervous children. Because of self-distrust, morbid suspicion, egotism, or "queerness," they adjust imperfectly to social environment, and are likely to withdraw into themselves, to contemplate life rather than to live it. In this way the abnormality is aggravated. The social outcast, whether he be one from choice or otherwise, usually lacks the finer elements of mental balance. The best corrective of character development is to have to face the natural social reactions which our conduct calls forth from others. " Es formet ein Talent sich in der Stille; sich ein Karakter in dem Strom der Welt."[1]

Methods of discipline

The hygiene of discipline plays no small part in psycho-prophylaxis. Nagging, arbitrary, or tyrannical parents and teachers either destroy the child's will or make it rebellious. The unstable and whimsical child is often but the victim of a nervous mother. The tyrannical, domineering father need not wonder when his son develops into a psychasthenic, weak, vacillating, and dependent upon others for guidance.

Training in self-reliance and self-control

Parental over-solicitude and excessive affection likewise tend to make the child dependent and to develop a mania for sympathy, the *besoin d'être aimé.*[2] The love bonds of infancy should normally dissolve as the child reaches maturity and be replaced by a tie of somewhat different nature. When this does not occur, when the relation of child to parent retains its infantile quality, the foundation is laid for a life of weakness and nervous invalidism. How to free the child from the circle of parental influence, without endangering the mellower filial attachment which should

[1] Talent is nourished in solitude ; character, by a life of action.

[2] Abnormal craving for love.

succeed it, is one of the important problems of child-training.

Self-reliance does not grow up out of habits of dependence, nor does steadfastness develop out of uninhibited impulses. If we would free children from bondage to their whims, we must train them to concentrate, to attend. The power of concentration is not a faculty, but rather the whole volitional attitude toward one's work, a function which enters into all of one's intellectual activities. It cannot be profitably trained by set exercises. What one has of it represents the total effect of the countless individual strokes of attention which one habitually gives. If these are allowed to be brief, aimless, or ineffectual, the injury so wrought cannot be corrected by a few formal exercises. Short-cut processes and pedagogical dosage can no more take the place of real education than patent medicines can replace the hygiene of physical development. In its play and in its work the child should, therefore, be encouraged to concentrate instead of being interrupted and dragged from one exercise to another.

The extreme suggestibility which marks the hysteria psychosis is best combated by a training which fosters, without overworking, the power of inhibition. As Williams well says, let the child "be taught not to strike, not to follow, not to jeer, not to give in, even though others do so." Let him "learn to take pride in being his own man, and not a puppet in the hands of others" (61). The culture of rationality also helps, for the hysterical is first and last uncritical. Whims and shallow impulsiveness do not thrive in the light of reason. Hysteria will be less common when education, from the kindergarten to the university, has more of the scientific background. Irrational prejudices can be combated by the same means.

Cultivating efficiency

Since habits are so much more persistent than is usually believed, there is special danger in the slump, intellectual or moral. The habits of peevish selfishness and fretfulness which are favored by a temporary illness, with its bodily weakness, sympathetic nursing, and friendly solicitude, sometimes remain and poison all the rest of life. When children are not kept to their best level of scholarship they suffer an intellectual slump. Herein lies the great danger of making school work too easy. By holding every child to the lock-step of regular school performance, genius is effectually starved. The child with real ability is enslaved by "habits of inferiority" to his own best self. By dint of repeating things which are already known, or by being kept over-long at what is easily acquired, the mind becomes prematurely arrested. Curiosity is deadened and all the higher intellectual processes stunted. Harris, James, and Sidis have dwelt with emphasis on this important principle of education.

Perhaps all of us have reserves of energy which we habitually fail to use and rich intellectual possibilities which we have failed to realize. The gates to these treasures are closed and sealed by the low opinion we entertain of ourselves, by the discouragement and self-distrust incident to failure, and by other inhibitions or repressions. As a means of tapping the hidden treasures of power, James instances the dynamogenic effect of ideals, religion, patriotism, critical experiences, etc.; Sidis, the loosening of the inhibitory stresses by suggestion, by hypnoidization, or by otherwise convincing the subject of the reality of his unused powers. What the psychasthenic lacks mainly is the conviction of strength, not strength itself.

Failure and success may indicate ability or they may be the mere products of habit. That a majority of children fail of promotion once or oftener during their school life is one of the sad facts in our present scheme of education. Still more deplorable and costly, however, is the failure of the talented few to go through school at the high level of intellectual performance possible to them.

The sanifying effects of work

The healthful influence of work has already been mentioned. The "instinct of workmanship" is one of the most generic of human motives, and when given a suitable outlet is one of the most sanifying. Especially to be emphasized is the wholesome effect of objective interests and employments as an antidote to morbid self-analysis and one-sided imagination.

Vocational guidance thus becomes an indispensable agent in preventive mental hygiene. There is no hope for the neurotic individual who is not successfully engaged in useful and interesting work. Hysteria is preëminently a disease of the unemployed, or the aimlessly employed. Work which is interesting and fruitful so engages and practices the synthesizing powers of will, so unifies the personality, that disagreeable and submerged experiences have no chance to produce their effects of mental disintegration. The moral as well as the industrial efficiency of the world would be easily doubled if each individual were doing the work for which he is best adapted.

Danger of shock

It is a matter of common observation that neurotic disturbances are frequently ushered in by a shock, such as accident, sudden grief, fright, disappointment, etc. A woman may become insane after the death of her child, the school girl may develop chorea or stuttering immediately after a fright. In such cases the grief or fright should not be regarded as the sole cause, but rather as the occasion for bringing forth what is already latent and near the surface. Shocks of grief, pain, fright, etc., do not start neuroses with every one. Nevertheless strong emotions suddenly induced are likely to produce injury and should as far as possible be avoided. The child's life should be one of fairly even tenor, at least until character and personality have had time to set.

Many other principles of preventive mental hygiene could be listed and illustrated, but perhaps enough has been said to show that, in the main, the principles involved are those of right education generally. The same may be said for the methods of psychotherapy, or mental cure, which are coming to rely more and more upon the method of reëducation. By following the strands of a neurosis back to its starting-point, back to the shock, or fear, or mental conflict which gave it birth, the fault in mental development may be corrected. The fears may be rationalized, the conflicts aired, so to speak, and brought to an understanding. Timidity may be educated out and replaced by confidence, hope, and the habit of success. But the process of reëducation is slow and its issue sometimes doubtful even when guided by the competent psycho-pathologist. Moreover, the latter is rarely available; there are not more than a few dozen in the entire country. It is easier and more effective to manage the work of education in such a way that reëducation will become less frequently necessary. All of the school's activities will ultimately be judged by the contribution they make to preventive mental hygiene in the broad sense.

Children's sorrows

To many people the sorrows of children are but foolish tears; their deepest griefs, humiliations, and disappointments seem but transitory affairs. Nothing could be further from the truth. Children's emotions are more compelling than our own; their sorrows are the most real there are. The child lives in the present, and his griefs, unlike those of men and women, are little mitigated by the memory of former joys or by the hope of others yet to come.

All of this and much more relating to the tragedies of childhood is painfully depicted in the recent literature on children's suicides. These seem to be on the increase in most civilized countries, and to show a tendency to occur lower and lower in the age scale. If the figures for France and Germany hold for the United States, it is probable that the annual number of suicides of children under 17 years of age amounts to about 500, and that the total number under 21 years exceeds 2000.

Eulenberg's analysis of 1117 cases in Germany indicates that over one third of all were caused wholly or in part by the school. The causes most often named in this connection are fear of punishment, failure of promotion, unjust treatment, mental overwork, etc. Even when the school is not the fundamental cause of the school child's suicide, it is often blamable for failure to recognize the morbid mental condition and to surround the child with the appropriate counteracting influences.[1]

Special schools for nervous children

In closing this chapter mention should be made of the rural school homes (*Landerziehungsheim*), which are becoming popular in Germany for nervous or otherwise troublesome children.[2] Such schools have their

[1] For a discussion of this entire subject see reference 53, where the author has set forth the statistics and summarized the causes.

[2] See, especially, references 33 and 54 at the close of this chapter.

gardens and fields to cultivate, parks, swimming-pools, athletic fields, and endless opportunity for outdoor living, country tramps, etc. They are usually conducted on the cottage plan, and are provided with medical and dental supervision and treatment. The study program is somewhat shorter than that of the usual public school, sports and manual occupations have larger scope, and discipline is more natural, and confined principally to inculcation of the essentials of right conduct. The social spirit of coöperation and mutual helpfulness is fostered. The instructors are comrades and leaders rather than teachers in the ordinary sense.

The rural school home is especially desirable for the child whose home environment is faulty and for children of neuropathic tendency. Besides providing the ideal hygienic environment, it has a special advantage in the fact that it can order the entire life of the child as long as he is in attendance. Too often the good that is daily wrought by the ordinary day school is undone before the following day by the evils of home life or by uncontrolled street associations. Although we cannot hope to have enough rural school homes for more than a few of the children who would profit from the treatment, they stand in many respects as an admirable model pointing the way to needed and possible reforms in the conduct of education everywhere.

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CHAPTER XIX

SPEECH DEFECTS AND THE HYGIENE OF THE VOICE

Stuttering as a handicap

THE stuttering child presents a tragedy to which a majority of teachers and parents are strangely blind. At home the onset of the disease is a signal for impatience and reproof on the part of the parents. They often interrupt the child's speech with scolding or with peremptory orders to cease stuttering. School entrance does not mend the situation, but is itself a new crisis. The child notes with humiliation the looks and smiles provoked by his speech efforts. The teacher herself, if not exceptional, is prone sooner or later to lose patience and to upbraid the unfortunate in the presence of his fellows. She may accuse him of carelessness, or neglect to call on him for a recitation, and may even discuss his defect with other children in his presence. The trouble is, of course, aggravated. Every speech sound which offers the slightest difficulty becomes the focus for a stubborn phobia. These difficult sounds are more and more slurred over in fear. The very thought of having to attempt them may throw the whole vocal and respiratory mechanism into a panic.

Though equal to other children in intelligence, the

[1] For some of the material in this chapter the author is indebted to Dr. Hudson-Makuen, of Philadelphia, and Dr. E. W. Scripture, of New York City.

stutterer, as Conradi's statistics prove (4), is likely to fail in classwork and to become retarded. The repetition of stale school work deadens interest with disgust. The child receives a training in failure. On the playground he encounters jests, badinage, and sometimes ridicule. In the shop and on the street grown men amuse themselves at his expense. The victim's whole existence is poisoned. The more sensitive stutterer comes to prefer silence to ridicule. He retires into himself, and as a result often becomes ill-tempered, hypochondriac, suspicious of others, or disagreeable. Lifelong moral suffering and permanent defects of character may be the issue. If the speech does not become normal, the vocational outlook is altogether unpromising. There is no place for the stutterer in law, medicine, the ministry, teaching, or many lines of business. Even marriage, on terms of social equality, is made difficult.

The incidence of speech defects

When we add to these considerations the fact that the number of stutterers exceeds the combined number of deaf, blind, and insane (for whom all civilized governments have acknowledged the duty of making liberal provision), and when we remember further that a large majority of speech defects could be readily and inexpensively cured, the usual apathy assumes almost the aspect of cruelty.

The incidence of speech defects in school children has been investigated by Westergaard and Lindberg in Denmark, by Von Sarbo in Hungary, by Rouma in Belgium, and by Conradi in the United States. The following table shows the most important findings of these investigations: —

TABLE 30

Country	Source of data	Number of children	Per cent with speech defects	Per cent stuttering	Name of investigator
Denmark		34,000	2.2	.61	Westergaard
Denmark	Country	212,000	–	.9	Lindberg
	Cities	85,000	–	.74	Lindberg
Hungary	Cities and Towns	231,000	–	1.02	Von Sarbo
Belgium	Cities	14,235	11.5	1.4	Rouma
United States	Cities	87,440	2.46	.87	Conradi

If Conradi's statistics, which were collected in Milwaukee, Cleveland, Louisville, Albany, Springfield, and Kansas City, are representative for the United States, then our school population contains about a half-million children with speech defects, nearly 200,000 of whom are stutterers.

All the authorities agree that speech defects are much more common with boys than with girls, the ratio usually being about 3 to 1. The following explanations, none altogether satisfactory, have been suggested by various writers to account for this superiority of girls: (1) The greater amount of language correction and instruction which girls receive as a result of their more intimate relations with the mother during childhood. (2) The relatively quiet and unexciting mode of life to which girls are accustomed.

(3) The preponderance of the costal type of breathing with girls. (4) The innate superiority of the girls in grace and accuracy of physical movement in general, seen also in their superiority over boys in writing, drawing, and other hand-work, and in the smaller amount of left-handedness. (5) The phylogenetic explanation that the domestic life which woman has led since the most primitive times has given her opportunity for more continuous practice of the speech function than has been the case with man. Observation (4) is probably a correct one, but leaves the fundamental difference in the physical dexterity of the sexes unexplained. The phylogenetic explanation need hardly be taken seriously.

The terminology of speech defects is poorly defined in the English language. The main defects, however, are two in number, designated in German as "Stammeln" and "Stottern"; in French as "blésité" and "bégaiement." Both the English terms "stuttering" and "stammering" correspond to the German "Stottern" and the French "bégaiement," but "Stammeln" and "blésité" have no exact equivalent in our language. "Lisping" is coming slowly into use as the technical equivalent of the latter terms, but in popular language is usually restricted to that defect which consists in the substitution of the *th* sound for *s* or *z*.

Lisping

Lisping is the most common speech defect, especially in the lower grades and the pre-school period. It includes the inability to pronounce certain letters or combinations of letters, and the tendency to omission, transposition, substitution, or slurring-over of sounds. It is found to greater or less degree in the speech of all young children and constitutes the most characteristic feature of "baby talk." It may be considered abnormal only when it noticeably persists beyond the age of 5 or 6 years. The frequency, as we should naturally expect, decreases rapidly in the upper grades of the school.

The accompanying chart from Rouma (22) shows for boys and girls separately the gradual decrease in the percentage of lisping during the first six grades. The investigation included 15,846 children.

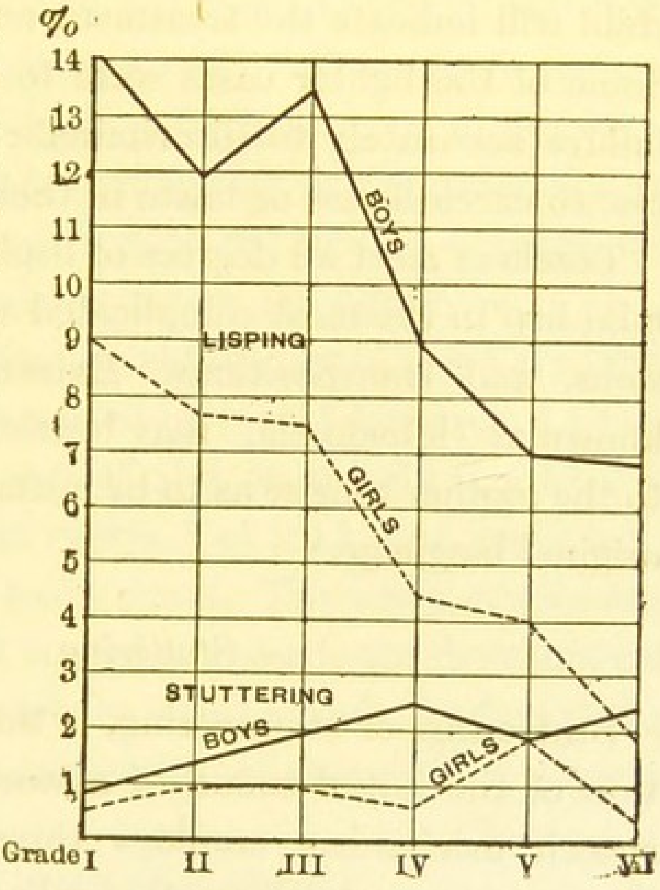

FIG. 22
Percentage of children lisping or stuttering in the first six grades. (After Rouma.)

The undue persistence of lisping may be due: (1) to lack of practice in the proper use of the articulatory organs due to bad models in the child's language environment; (2) to weakness of the auditory center; (3) to incomplete development of the speech organs; (4) to anatomical abnormalities of teeth, lips, tongue, jaws, soft or hard palate, nasal or pharyngeal cavities, etc.; or (5) to a general deficiency of the motor centers. The above factors may be operative in different combinations, and only a careful clinical study of the individual child will indicate the treatment necessary for a cure. Some of the lighter cases seem to be due either to a failure accurately to discriminate speech sounds, or else to carelessness or haste in their reproduction.

Teachers meet all degrees of lisping, ranging from a mild lisp to the most complicated substitutions, omissions, and transpositions. Extremes of the latter, known as "idioglossia," may bear so little resemblance to the mother tongue as to be mistaken for an entirely original language.[1]

Stuttering

Stuttering, or stammering, is the spasmodic repetition of the initial sound of a word or syllable. The speech mechanism employs three sets of muscles: those of (1) respiration, (2) vocalization, and (3) articulation. All of these must function together in the most delicate coördination if normal speech is to be produced. The incoördination of stuttering involves a cessation or interference of the respiratory movements, together with excessive innervation of the vocal muscles and a spasmodic contraction of the articulatory

[1] For an interesting description of idioglossia the reader is referred to chapter XXI, reference 8.

muscles. The excessive innervation, or hyperphonia, is perhaps the chief feature.

Stuttering is by far the most important of the speech defects and deserves a more extended treatment than is here possible. Unlike lisping, its frequency increases from grade to grade, at least up to the age of 10 or 11 years. Rouma found an increase of 200 per cent from the first to the fourth grade (22). From the investigations of Denhart, Sikorsky, Mygind, and Oltuszewski,[1] it appears that a large proportion of the cases of stuttering are contracted before the age of 6 years and nearly all the remainder before the age of 14.

The results of Oltuszewski for age of onset are typical. Of 535 cases reported by him, 7 began at 2 years, 50 at 3, 67 at 4, 64 at 5, 47 at 6, 32 at 7, 39 at 8, 16 at 9, 24 at 10, 6 at 11, 6 at twelve, 7 at 13, 2 at 14, and a total of only 6 from 14 to 21 years. The lower grades are, therefore, the most crucial as regards the development of the disease, though the onset of puberty frequently brings about the aggravation of cases which already exist.

Causes of stuttering

The influences causing or predisposing to stuttering may be grouped into six classes: —

(1) The reflex, including adenoids, enlarged tonsils, defective teeth, etc. Of these, adenoids are the most important and are found with from 35 to 40 per cent of all stutterers. Dr. Bresgen thinks that nasal or pharyngeal obstructions are at the bottom of nearly all speech

[1] Cited by Conradi, reference 3.

defects. He thinks that, besides offering resistance to the sound waves, such obstructions render less easy the use of the muscles which are called into activity for phonation and articulation. This brings other muscles into requisition and leads to faulty coördination.

(2) General weakness, including low muscular tone due to malnutrition, illness, overwork, etc. The anæmic are especially subject to the defect. Of Mygind's 200 cases, 18 followed acute illnesses, — measles, scarlet fever, pneumonia, whooping-cough, diphtheria, and mumps, named in order of frequency. School overpressure, worry, deprivation from fresh air, and insufficient exercise are often unmistakable factors.

(3) Psychical causes, including shock, imitation, morbid fear, hysteria, etc. Baginsky and Gutzmann think that imitation is the most common cause of stuttering. One case is cited where a teacher with 60 pupils had one stuttering pupil at the beginning of the school year and five at the end. A severe shock, such as a blow on the head or other physical injury, sometimes produces temporary speechlessness followed by stuttering. Agonizing fright may act in the same manner. Out of 535 cases analyzed by Sikorski, 23 are attributed to fright, 47 to injury, and 30 to imitation. The influence of imitation can, of course, never be weighed with absolute accuracy because of the difficulty of ruling out all other possible factors.

(4) Heredity. All are agreed that heredity plays a large part, a majority of investigators assigning it first

rank. Coen finds evidence of inheritance with $26\frac{1}{2}$ per cent, Mygind with 42 per cent, Altuszuski with 45 per cent, Sikorski with 73 per cent, and Arndt with $77\frac{1}{2}$ per cent. The last mentioned authors have used the term "heredity" in a very broad sense, including evidence of all kinds of neurotic diseases in even distant branches of the family. Among Mygind's 200 cases, 84 were found who had a total of 124 stuttering relatives. Of the latter, 62 sustained the relation of brother or sister to the patients. Out of the 200, 32 had a total of 36 relatives who had suffered epilepsy or other convulsions. Of the 200 cases 58 had relatives to the number of 73 who had suffered "nervousness," neurasthenia, hysteria, or nervous headache (migraine). Even when the immediate causes are especially prominent (fright, physical injury, illness, worry, fatigue, imitation, etc.), probably in most cases these operate in conjunction with a neuropathic constitution.

The kinship of speech defects to other neuroses is also indicated by the fact that they are excessively prevalent among retarded and mentally defective children. Rouma found lisping about twice as frequent and stuttering about three times as frequent among the retarded as among normals, while feeble-minded children showed about seven times the normal frequency for stuttering. Miss Town's study of the language development of 135 imbeciles showed that only 14.7 per cent of the low-grade cases were entirely free from lisping or stuttering, 38 per cent of the middle grade, and 45 per cent of the high grade (26).

(5) Pedagogical maltreatment, such as ill-advised phonic drills and other faulty methods employed in the teaching of elementary reading. No statistics are available on this point, although it is one that has been repeatedly urged. Dr. A. Melville Bell and Dr. Hartwell have charged the schools with being the "breeding-ground of the stuttering habit," and have laid the blame largely on "misguided methods of instruction in reading and speaking." As pointed out by Huey,[1] prevalent methods in phonics and in teaching to pronounce and to read aloud call the child's attention too much to the "how" of utterance and tend to produce a "mouth consciousness" which interferes with a process which was meant to function automatically. The coördination once established, the further consciousness stays away from the process the better. Its intervention produces nervousness, awkwardness, and embarrassment, and is likely to balk the coördination completely. Work in phonics need not be excluded from elementary instruction, but it should be limited to well-regulated drill for the correction of defective speech and to the necessary association in the child's mind of certain of the more difficult sounds with their language equivalents.

The influence of the nagging, sarcastic teacher is still more serious. The cause of stuttering is as much psychical as physical, and often has its roots in a morbid fear, or speech timidity, produced by the teacher's severity. Rapid-fire questioning, compulsory answers,

[1] *Psychology and Pedagogy of Reading*, p. 598.

overpressure, and the like, are other school factors in the manufacture of speech defects.

(6) Interference with normal left-handedness. Although it has long been believed that training left-handed children to the use of the right hand is likely to produce disturbances of the motor mechanism of speech, it remained for the painstaking investigation of Ballard (2) to establish the point beyond controversy.

Three separate studies were made by Ballard. The first was by means of a questionnaire addressed to the teachers of 13,189 London children. Of these children, 12,644, or about 97 per cent, were dextrals (i.e., right-handed); while the remaining 545, or 3 per cent, were sinistrals (left-handed by preference). Of the 545 normally left-handed children, 399 had been required to learn to write with the right hand. These Ballard calls "dextro-sinistrals." The proportion of stuttering children among the pure sinistrals (left-handed children who were permitted to write with the left hand), was 1.1 per cent; among the dextro-sinistrals, it was 4.3 per cent. Requiring left-handed children to use the right hand thus multiplied the number of stutterers in this group by almost four.

Ballard's second study of the relation between dextro-sinistrality and speech defects concerned 944 mentally defective children. Of the 882 dextrals, 14, or 1.6 per cent, were stutterers; of the dextro-sinistrals, nearly 20 per cent. In this case, therefore, training in right-handedness multiplied the chances of stuttering by twelve.

The third study was still more decisive. In this, Ballard made personal examinations of all the sinistrals (322 in number) found among 11,939 children, 8 to 14 years of age. Of the 322, 271 had been required to write with the right hand. Of these, 46 stuttered at the time and 24 had stuttered previously and recovered, or 25.8 per cent in all. Of the 51 sinistrals who had been permitted to use the left hand, not one stuttered. The proportion of stutterers among dextro-sinistrals was, in this investigation, about eighteen times as great as among pure dextrals.

Accepting the latter figures as the basis for our computation, it would appear that not far from one third to one half of the stuttering among London school children is produced in the effort to make right-handed children out of those who are normally left-handed. At least we are justified in concluding that the attempt to do this increases many times the liability of stuttering.

The physiological mechanism responsible for the relation between "handedness" and speech control is not sufficiently understood to warrant a discussion of the various explanatory theories which have been advanced. The fact that the relationship exists is sufficient for practical purposes. Left-handed children should remain left-handed, for writing at least. The slight advantages which would accrue from a change are entirely outweighed by the dangers to speech.

In passing, it is interesting to note that left-handedness is twice as common among boys as among girls, and since, therefore, an absolutely larger number of left-handed boys than left-handed girls are made to write with the right hand, this may account in part for the sex differences among stutterers.

Whether other motor activities have the same effect as writing is not certainly known. Ballard believes, however, that the chief danger lies in the attempt to change the handwriting.

The treatment of stuttering

In whatever way stuttering has been caused, it is curable in at least nine cases out of ten. The work in foreign countries has demonstrated this abundantly. The fact that a few stutterers recover spontaneously has contributed to the neglect of curative treatment. To adopt the waiting policy with stuttering is no more justifiable than the omission of open-air treatment of tuberculosis. Stuttering, like bad grammar, tends, if persisted in, to become confirmed.

Unfortunately, the treatment of stuttering is almost completely monopolized by quacks. Each "stutter specialist" boasts a secret, sometimes copyrighted, method. Outrageous prices are charged for a kind of treatment which is anything but scientific, and which, while curing some cases, leaves others in a worse condition than before.

What could the school do for stuttering children? The admirable study reported by G. Rouma (23) summarizing the educational efforts in behalf of stutterers in European schools, affords an authoritative answer to this question. For many years the larger cities of Germany, Austria, Switzerland, and some other European countries have conducted special schools for the benefit of stutterers. Several types of such schools may be distinguished: —

(1) The school vacation colony. Zürich, for example, conducted such a school in 1899. The school, which was attended by 21 children, met daily in a forest near the city. The morning hours were devoted to language exercises, breathing lessons, etc., while the afternoon was given over to games, tramps, and other forms of physical recreation. Though the school lasted only three weeks, several were cured and all were improved. Since then, Zürich has conducted an all-summer school for stutterers with a daily session of three hours. In the summer of 1902–03 the school was attended by 194 children. At the close of vacation, 146 were entirely cured and all the others except two were improved. This type of school is especially valuable, for the reason that the stuttering child is so often weak, nervous, anæmic, and in need of general physical upbuilding.

(2) After-school lessons. This is the type of school most in vogue at present in the countries of Europe. The exercises last about an hour each day, and are given by a teacher who has had special training for the work. The method usually commends itself to the school authorities because it does not interfere with the pupil's regular school lessons, but it is open to criticism in that it comes at a period when the patient

is already fatigued. Moreover, it interferes with the recreation and exercise so much needed by most stutterers. Still another disadvantage is that when the treatment is made such an incidental matter, it does not always enlist the enthusiasm and voluntary effort so necessary in overcoming the defect.

(3) Treatment within school hours. This is the method which has been employed in Berlin since 1901, and throughout Hungary. Like the special classes of type (2), these also meet daily, usually for one hour, and are ordinarily limited to a maximum of twelve pupils. Practically all the stuttering children in the cities of Hungary are treated in this way.

In Berlin, Brussels, and Buda-Pesth, schools of orthophonics are conducted every year for the purpose of training teachers in the art of curing speech defects. Hungary has over two hundred teachers equipped for the educational treatment of stutterers. These are nearly always regular teachers who receive an additional salary for the special work and are excused from a part of their other teaching duties.

(4) A few European cities have established all-day special schools for stutterers. These, in the opinion of Rouma, are the ideal kind, because they allow a more thorough treatment than is possible by any other procedure. All the work of such a school can be adapted to the special needs of the patients, and the personal relations of teacher and pupil have time to become firmly established. Schools of this type recognize that stuttering is not merely a defect of speech,

but that it involves usually an extended zone of nervous defectiveness. They are often not feasible, however, except in the more thickly populated cities, for the reason that it is necessary for some of the pupils to travel long distances to attend them. Another objection sometimes made to this method of treatment is that removal of the stuttering child from association with normal children is likely to accentuate his consciousness of defect and in this way retard recovery. In actual practice, segregation does not seem to have this effect. Instead, in the opportunity it gives for emulation and class spirit, together with the release it affords from the atmosphere of criticism which so often oppresses the stuttering child when taught with normals, the special all-day class has distinct and important advantages.

Schools of all the types above mentioned are remarkably successful. As a rule, recovery is complete within four or five months, and only rarely does a case prove entirely intractable. When a relapse occurs, as sometimes happens, the child is given a second course of treatment, or even a third if necessary. Because stutterers are likely to be misunderstood, badgered, and otherwise nervously maltreated at home, it has been found helpful to furnish parents with a pamphlet of instructions and to urge in personal conferences that they adopt an encouraging and sympathetic attitude toward the child. The ignorance of parents is one of the sad features of the situation. Sometimes they inveigh against the treatment, call it useless, a waste of time, etc. Others consider it an unjustifiable interference with the ways of Providence, who, they think, furnished the child with a thick tongue and meant for it to stutter.

Treatment is most successful where each case is recognized as a special problem. Since the defect does not always arise from the same cause, it does not always need the same treatment. Extensive information is gathered and recorded regarding each child. This includes age, class, school progress, mental condition, condition of nose, throat, ears, teeth, vital capacity, motor ability, evil sex habits, age at which walking and speech were learned,[1] age of dentition, record of illnesses suffered, condition of nutrition, and complete data regarding all nervous troubles both in the child and his immediate relatives.

Methods used in the treatment of stuttering

A minute description of the methods employed in the treatment of speech defects would carry us beyond the scope of the present chapter. These will be found in the German works of Gutzmann and Liebmann, and in the American volume by Scripture.

No one form of treatment has been generally agreed upon. Any method, to be successful, must be based upon a scientific understanding of the essential nature of the defect. The usual methods employed in the American private schools for stutterers are coined out

[1] The stuttering child often has a history of retardation in one or both of these functions.

of truth and fraud in the proportion of about one to nine. To use the illustration given by Dr. Hudson-Makuen (12): —

> A stammerer is told to nod his head whenever he speaks, and because this procedure happens in this particular case to divert his attention sufficiently long to enable him to speak freely for a time, the quack thinks he has made a discovery, and immediately evolves a theory and establishes an institute with a secret method which consists solely in nodding the head in unison with the natural speech. Another advises beating time with the forefinger or thumb, or with the hand or foot during the process of speaking, and each of these schemes has been dignified as a "method" which is dispensed for a consideration under bonds of secrecy. There is even now a separate and distinct method which characterizes nearly every school and teacher engaged in the work, and these methods in many instances amount to little more than tricks.

The partial success of such methods is due to the fact that the stutterer's trouble is to a great degree a mental one, — "a mental tic," as one writer has characterized it. The child stutters because he fears he will stutter. It is quite essential that the patient's self-confidence be aroused. He must forget that it is any longer possible for him to stutter. Appropriate speech exercises, proceeding very slowly from the easiest to the more difficult, and adapted to suit the needs of the individual case, gradually overcome timidity and dissipate the language obsessions. As stated by Makuen (13): —

> If he has weak will power, we must show him how to

strengthen it. If he lacks the faculty of attention or concentration, we must show him how to acquire it. If he has grown morbidly introspective and self-conscious, he must be shown how to overcome this condition. If he is suffering from fixed ideas and obsessions, if he has become neurasthenic or psychasthenic, as many of them have, he must be cured of these diseases before he can possibly be cured of his speech malady. In other words, he must learn to control himself before he can hope to control his speech.

Correct habits of respiration have to be learned, for as a rule the stutterer has not learned how to breathe properly. Although adenoids, enlarged tonsils, impacted teeth, etc., should always be carefully attended to, it should be understood that stuttering is not primarily an affection of the tongue, lips, palate, or pharynx. The stutterer's speech is faulty in every particular. His whole nervous system is likely to be at fault. He may "stutter" in his emotions, his thinking, and his willing. The trouble is more central than peripheral. The treatment must have for its purpose a reëducation of the individual's speech habits, the general upbuilding of his physical health and the improvement of his mental condition.

Stuttering is more an educational than a medical problem. The contention sometimes voiced, that the disease is one which can be successfully and legally treated only by a physician, is an absurd and educationally pernicious doctrine. Not one physician in a thousand knows any more about the treatment of stuttering than he does about the teaching of Sanskrit. It is essential, however, that stutterers be kept under close medical supervision for the improvement of general health and for the treatment of specific physical defects. The actual task of working over the speech habits of the stutterer can be more successfully accomplished by special teachers in the public schools at only a small fraction of the expense that would attach to the prolonged services of a competent physician. Speech defectives have been too long exposed to the questionable practices of institutions conducted for gain. Wherever stuttering is dealt with in the European way, it is cured easily, quickly, and at insignificant expense.

It is plainly the duty of our normal schools to give the special training needed for this work. If at least one normal school in each State offered an annual course in orthophonia, we should soon have the requisite number of special teachers. European experience shows that the training can be secured in a course extending over a single year with one or two lessons per week. The training should include not only theory, but also demonstration and practice.

But the classroom teacher does not need to wait for the educational machinery to move. With a little time and much patience any sensible teacher can accomplish a great deal in the improvement of defective speech. The work of Liebmann proves that the extremely elaborate drills in articulation, enunciation, and breathing used by some specialists are by no means always essential to success. The following simple directions will be found helpful: —

Arrange with the child to remain a half-hour after school three or four times a week for a speech lesson. Let this consist largely of conversation in the low ordinary tone of voice. Convince the child that he will be able to overcome the defect. Repeat this assurance until it becomes an absolute conviction. Stuttering will ordinarily not cease as long as the fear of stuttering remains. Stuttering is really a speech phobia. Embarrassment always aggravates it. The child stutters because he is convinced he will stutter. He sings normally; hence the trouble does not lie in the speech organs themselves, but in their control. Control is balked by emotional stresses, or "repressed emotional complexes." The stutterer is tense. The followers of Freud claim that stuttering is always a form of anxiety neurosis. The patient must be freed from the morbid anxieties which have their seat in the subconscious life. Sometimes the whole character needs to be reformed. The patient, being oversensitive, may be suspicious of others, always on the lookout for signs of unfriendliness. He must be taught to take a reasonable attitude toward his defect and toward people. Disagreeable experiences which have been repressed and embedded in the subconscious life should be dug up and reconciled with the daylight of consciousness. The stutterer is a victim of internal mental conflicts. He is nearly always subject to doubts, scruples, hesitation, etc. As Freud and Appelt have shown, these may be dissipated by the methods of psychoanalysis. It appears, however, that any kind of treatment will accomplish the same result which encourages self-confidence, fosters reasonableness, and loosens the inhibitions. The stutterer must learn how to relax.

The fear of stuttering can only be relieved by a little experience with successful speech. The foundation for this can be laid in simple exercises in singing. The patient is thus convinced that untrammeled enunciation is possible to him. Exercises in repeating easy sentences are also helpful. As self-confidence grows, these may be replaced by declamation. Always encourage the child. Call his attention to the slightest sign of improvement. Dwell on successes; lead him to forget the failures.

In the child's reading and conversation, cultivate expressiveness and melody. The stutterer, as has been shown by the researches of Scripture, jerks out his sentences almost in a monotone. Such a sentence as "How do you do?" is droned out in an uninflected tone which may be represented as follows: —

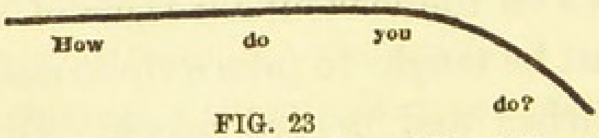

FIG. 23
Line indicating the monotony of the stutterer's voice. (After Scripture.)

The melody drill should be kept up until the child can say: —

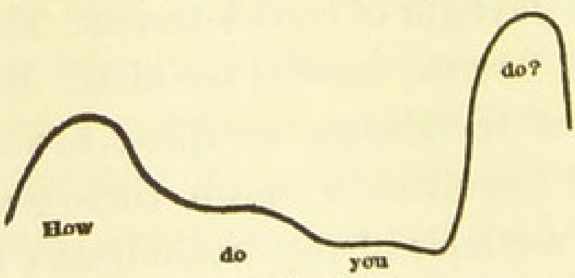

FIG. 24
Line indicating how the normal voice should rise and fall in speaking the phrase "How do you do?" (After Scripture.)

Further details as to methods of curing stuttering, together with elaborate exercises and directions will be found in the excellent book by Scripture, which should be in the hands of every teacher who has a stuttering child in her class.

The treatment proper should not be given in the presence of other children, though two or more stutterers may be treated together. Encourage the child to recite frequently in his regular classwork, and never correct his defective speech in the presence of his classmates, or even appear to notice it. The stuttering child is often among the brightest in the class. Take care to see that he lives up to his best level of performance. Do not permit him to fail even in unimportant matters, where it can be avoided. Show interest and confidence in him as regards all sorts of things, in school and out. If partiality in a teacher were ever forgivable it would be in the case of the timid stutterer. It is also well to talk with the parents, both to explain your efforts in the child's behalf and to urge their coöperation. Without alarming them with exaggerated statements regarding the seriousness of the defect, explain clearly the handicaps which it involves.

The prevention of stuttering

The best time to cure stuttering is before it begins. It is important, therefore, that every teacher have some knowledge of speech disturbances and the hygiene of the voice. She should understand that worry, embarrassment, and excitement are important immediate causes of speech defects. In the words of Conradi (3): "If the school is a place of nervous tension; if the child is constantly worried with abstractions ill-fitted for the child mind; if it is asked to express its confused ideas under the eye of an ever critical teacher who conceives of her day's work as six long hours of wearisome labor — we have the ideal conditions for the onset of functional speech disturbances."

Physical defectiveness and general health should be looked after with especial care in the case of weak, nervous children who show any tendency to speech defect. A life of quiet and calm should be fostered. Self-confidence should be diligently cultivated, for it is the nervous child's chief defense against stuttering. To upbraid the child for any imperfection of speech is not only brutal, but is certain to confirm and exaggerate the defect.

Any tendency to hurried, blustering speech should receive early attention. The success of the "melody cure" in the treatment of stuttering suggests the great importance of the cultivation of melody and expressiveness in the lower grades as a means of preventing the onset of the disease.

At least one fourth of the children who enter the first grade of school have not fully recovered from the lisping and speech clumsiness of childhood. It is mostly from these pupils that the ranks of stutterers are recruited. For this reason, Rouma and others have urged that the first months of the school be given over to informal exercises in oral language designed to get the children once for all into correct habits of speech. There is no pedagogical justification for the anxious haste of the primary school to teach children to read. Moreover, if the informal oral work here recommended were substituted for some of the more formal work of reading and writing in the early months of the first grade, the transition from the free, play life of the kindergarten to the primary school would be made more easy and natural. If one half of the time usually wasted on nonsensical phonic drills were devoted to the cultivation of an easy and pleasing conversational voice not only would many cases of stuttering be prevented, but the traditional "American voice" would lose some of its disagreeable flavor.[1]

We should attach as much value to the correction of slovenly and disagreeable speech as to the correction of spelling, grammar, and manners. Speech habits are only plastic till adolescence, and the responsibility of teachers in the cultivation of speech is therefore very great. Melody and expressiveness of utterance should be an important aim of the school. If every child were given the treatment appropriate to the incipient stutterer, no one would suffer thereby and the speech of even the normal children would be greatly improved.

[1] As characterized by Scripture, the "American voice" has three chief qualities: (1) hardness, due to excessive innervation; (2) the drawl, or slurring, due to speech laziness; and (3) nasal resonance, due to partly to habit and partly to catarrhal conditions.

Suggestions for observing speech defects

Does the child stutter?

Does he lisp (substitute certain sounds for others)?

Is the child "tongue-tied"?

Has baby-talk persisted unduly?

Is speech rapid or blustering?

Is speech jerky (staccato)?

Is speech slow or drawling?

Is the child unable to respond promptly?

Is enunciation careless (sounds slurred over or dropped)?

Is speech indistinct (words "chewed")?

Is the voice high-keyed or shrill? (Indication of nervousness.)

Does the child speak in monotones?

Has the speech exaggerated inflection?

Is it too loud?

Is it too low to be easily heard over the room?

Has the voice a nasal quality? (Adenoids, etc.)

Is there chronic hoarseness?

Has the voice changed? (Indication of puberty.)

Is there abnormal hoarseness?

Is dentition normal?

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CHAPTER XX

THE SLEEP OF SCHOOL CHILDREN[1]

SLEEP and food are two of the most imperative needs of the human organism. Each has its educational and economical, as well as its physiological and biological, aspects. But while diet has long received a liberal share of attention from economist, hygienist, and biologist, the scientific study of sleep has been hardly more than initiated.

Sleep is one of the biological rhythms stamped into the organism by the movements of the planet on which we live. To interfere unduly with such an ancient and physiologically established rhythm would theoretically appear to be an unsafe experiment. It is an instinct which involves the entire body, and is not simply a function of the brain. The brainless dogs of Golz and the brainless pigeons of Manaceine exhibited the same sleep rhythms after the removal of the cerebrum as before. Psychiatrists tell us that many mental disorders are preceded by protracted insomnia. Loss of sleep has been experimentally shown to cause a decrease in the number of red corpuscles, while the beat of the heart is accelerated to compensate for the poverty of the blood. Far from being a bad habit, as

[1] Written with the assistance of Adeline Hocking, Stanford University.

Girondeau believed, sleep has been evolved as the best biological means of making possible intense periodic activity of mind and body.

Besides acting to recharge the batteries of life, sleep has a settling and confirmatory influence upon the mental activities which precede it. To "sleep over a problem" is a means of transforming a chaos of puzzled mentation into order and clarity. The learning processes which are initiated during the work of the day take deeper root during the hours of sleep. In sleep, life purposes may mature and ideals take shape.

On the other hand, we must avoid overestimating the hours of sleep necessary. Sleep is but one of the many needs of children, and it is foolish to make it the scapegoat for all kinds of physical and mental evils, as hygienists have so often done. It is possible that the quantity of sleep is less important than its quality, and when disturbances of the latter occur, they are likely to be the effect of the ill health rather than its cause.

The amount of sleep needed

On this point we have a large number of estimates based upon opinion, but no certain knowledge. The theoretical norms set forth by Dr. Duke have been very generally accepted. Other noteworthy standards are those of Hertel, Bernhard, and Claparède. The difference of opinion which prevails is shown in Table 31.

TABLE 31. ESTIMATE OF SLEEP NEEDS (HOURS)

Age	5 to 6	7	8	9	10	11	12	13	14	15	16	17	18
Duke......	$13\frac{1}{2}$	13	$12\frac{1}{2}$	12	$11\frac{1}{2}$	11	$10\frac{1}{2}$	10	10	$9\frac{1}{2}$	9	9	$8\frac{1}{2}$
Bernhard..		11	11	11	$10\frac{1}{2}$	$10\frac{1}{2}$	10	10	$9\frac{1}{2}$				
Hertel	11	$10\frac{1}{2}$	$10\frac{1}{2}$	10	10	$9\frac{3}{4}$	$9\frac{1}{2}$	$9\frac{1}{2}$	9	9	$8\frac{3}{4}$		
Claparède..	$11\frac{1}{2}$	$11\frac{1}{2}$	$11\frac{1}{2}$	$10\frac{1}{2}$	$10\frac{1}{2}$	$9\frac{1}{2}$	$9\frac{1}{2}$	$9\frac{1}{2}$	9	9			
Manaceine.	14	11	11	11	10	10	$9\frac{1}{2}$	$8\frac{1}{2}$	$8\frac{1}{2}$	8	8 to 7		
Krollich....	11	11	11	11	$10\frac{1}{2}$	$10\frac{1}{2}$	10	10	$9\frac{1}{2}$	9	9	$8\frac{1}{2}$	$8\frac{1}{2}$
Cavanagh .		12											9
Brown	$11\frac{1}{2}$						10						
Pfaunder ..	11						9						
Key.......	11						10						

The above table shows a difference of opinion amounting to $2\frac{1}{2}$ hours for the age 6, $2\frac{1}{2}$ hours for age 7, 2 hours for age 8, 2 hours for age 9, etc. Duke recommends as many hours for age 18 as Manaceine for age 13; and as many hours for age 14 as Manaceine for age 10. Duke's estimate for 11 years equals Key's for 6 years. In like manner, twenty-nine medical officers of English schools, who were interrogated by Acland (1), estimated the sleep needs of 12-year-old boys all the way from 9 hours to more than 10.

Several investigations have been made of the number of hours children do sleep, though obviously we cannot in this way determine conclusively how many hours they ought to sleep. One of the earliest of these was by Hertel, who in his study entitled "Overpressure in the Schools of Denmark" presents sleep records from 3141 boys and 1211 girls in the schools of Copenhagen. These averaged about $10\frac{1}{2}$ to 11 hours of sleep at 6 years, the amount decreasing to $9\frac{1}{2}$ hours at 12 years, and to about $8\frac{1}{2}$ at 16 years. Sleep was most deficient among pupils pursuing the arduous classical courses, where it often fell to 6 or 7 hours. Acland found that the hours of "undisturbed rest" given to boys 10 to 13 years of age in forty English boarding-schools ranged from 8 to 10, averaging about 9. The actual time of sleep must have been somewhat less than this, and was certainly far below the amount physicians usually consider desirable.

Important investigations of the sleep of school children are those of Dr. L. Bernhard (3) and Dr. Alice Ravenhill (14). The former secured data from 6551 German children 6 to 14 years of age, and the latter from 6180 English children of about the same ages. The average amount of sleep for each year is shown in the following table: —

TABLE 32. SLEEP OF GERMAN AND ENGLISH CHILDREN

Age	Sleep in hours and minutes							
	6	7	8	9	10	11	12	13
Bernhard	10.20	9.50	9.25	9.20	9.10	8.55	8.25	7.50
Ravenhill	10.30	10.30	9.30	9.15	9.15	8.45	8.15	8.30 Boys
	10.45	10.30	10.15	9.30	9.30	9.15	8.00	7.30 Girls

Using his own estimate of the amount of sleep which children ought to have, Bernhard computes that the sleep deficiency among his 6551 pupils ranges from about an hour at the age of 7 to nearly an hour and three quarters at 14 years. This would represent a total sleep loss per year of over 400 hours for the average child of 6, and over 600 hours for the average child of 14 years. Miss Ravenhill, basing her estimate upon the standards furnished by Dr. Duke, finds an average sleep deficiency for English children of nearly 25 per cent; while that for girls of 13 years amounts to a daily loss of $3\frac{1}{4}$ hours. Children of 6 years were found who slept only 7 hours, and children of 12 years, 4 to 6 hours.

During the year 1911–12 the writer, with the assistance of Miss Adeline Hocking, carried out an investigation of the sleep of school children, which had for its purpose, (1) to ascertain by more careful methods than had yet been employed the hours of sleep of children in the Western States of America; (2) to discover what correlation exists between hours of sleep and school success; and (3) to find the relation of hours of sleep to social status, home study, and the possession of typical "nervous" traits. Records were secured from 2692 children between 6 and 20 years of age in the California cities of Stockton, San José, Alameda, and Los Gatos; Tempe, Arizona; and Monmouth, Oregon.

By means of a carefully planned and uniform procedure data were secured showing the exact time of retiring, the approximate length of time required for going to sleep, the exact time of waking, whether waking was spontaneous, how many other persons slept in the same room and the same bed, and the amount of ventilation in the bedroom.

The amount of sleep for these 2692 persons is shown in hours and minutes in the following table: —

TABLE 33

Age	No. of records	Av. no. of hrs. of sleep	Age	No. of records	Av. no. of hrs. of sleep
6– 7	37	11.14	13–14	250	9.31
7– 8	147	10.41	14–15	244	9.06
8– 9	218	10.42	15–16	201	8.54
9–10	291	10.13	16–17	167	8.30
10–11	307	9.56	17–18	117	8.46
11–12	282	10.00	18–19	43	8.46
12–13	312	9.36	University students	51	7.47

The most important fact in the above table is the striking excess of sleep among these children as compared with the German and English children of Bernhard and Ravenhill. This excess amounts for most ages to between one hour and one hour and a half. At the same time the sleep averages found in this investigation fall from three fourths of an hour to two hours below the theoretical standards set by Dr. Duke.

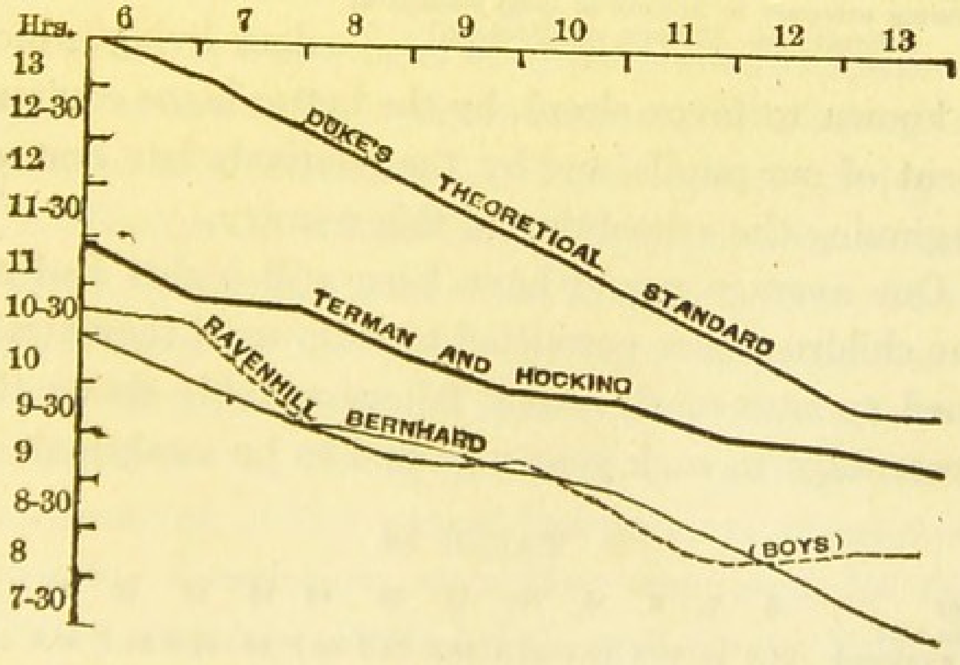

FIG. 25
Amount of sleep children actually receive compared to Duke's theoretical standard

These points of difference are shown graphically in figure 25.

An idea of the individual differences may be gained from figure 26, which shows an average difference of three to four between the ten highest and ten lowest for each age.

It is seen, therefore, that the average amount of sleep received by children in the western part of the United States very greatly exceeds that for German and English children. This may be accounted for by the differences in climate and in the amount of outdoor living (which is known to favor sleep), by the better home environment of our pupils, and by the relatively late hour of beginning the school day in this country.

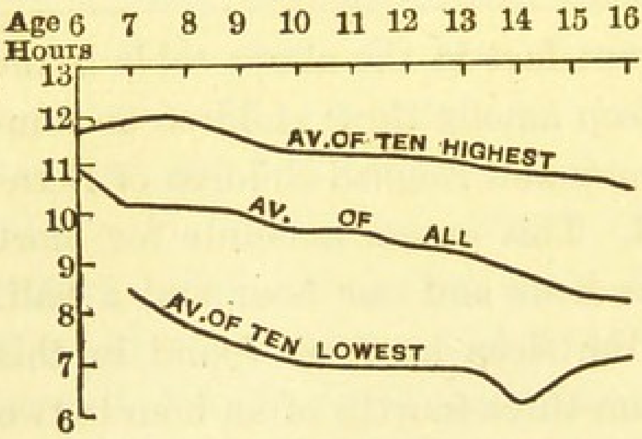

FIG. 26
Showing extremes in amount of sleep secured at different ages. (Terman and Hocking.)

Our average would have been still higher had all the children been permitted to sleep until they awakened spontaneously. The following table shows the percentage in each year who had to be awakened: —

TABLE 34

Age	6	7	8	9	10	11	12	13	14	15	16	17	18
Per cent awakened	21.2	19	23.3	19.1	22.8	20.3	23.6	24.7	26	31.6	38.7	39.9	47.7

The interesting fact here is the rapid increase in early adolescence of the number who did not wake spontaneously, probably due to the fact that a majority of the records above the age of 14 were from high-school pupils, who were required to do more evening work than the younger children.

Although it cannot be assumed that averages secured in this investigation furnish absolutely reliable norms of the amount children of various ages ought to sleep, it is believed that they are of more value for comparative purposes than any which have hitherto been available. The averages of Bernhard and Ravenhill probably show a sub-normal amount of sleep, while the traditionally accepted norms of Duke are certainly too high.

The relation of sleep to intelligence, to social status, and to nervous traits

In order to throw light on these points, supplementary information was secured from each of 1350 out of the total 2692 individuals. This included the degree of intelligence as estimated by the teacher on a scale of seven, the social status of the home as estimated on a scale of four, the number of "nervous" traits possessed by the child, and his school success. School success was measured by the child's grades in the different subjects received at the end of the previous quarter or semester. Correlations were then computed, for the different ages separately, by the well-known Pearson formula.

In every case it was found that there was practically no correlation, either positive or negative, between sleep, on the one hand, and intelligence, social status, "nervous" traits, or any school subject, on the other. The instances in which the coefficient of correlation exceeded +.10 or −.10 were so few and appeared so sporadically in the different ages as to be wholly without significance. It was even found that the school grades of the pupils sleeping the least averaged slightly above those of the ten sleeping the most.

How are we to explain a result so at variance with current belief?

One interpretation would be that the average child receives more sleep than he really needs. It has been experimentally shown that sleep ordinarily becomes superficial after four or five hours, and it has been suggested that this period of less effective sleep might be considerably shortened without material loss. In harmony with this, Weygandt's tests of mental efficiency seemed to indicate, for himself, complete recovery from the most difficult kinds of mental work after five hours of sleep (19). On the other hand, Netschajeff's experiments on the relation between his own sleep and mental efficiency during a period of four months show that the latter was affected by extremely slight deficiencies of sleep. Further investigation is urgently needed.

A second explanation of the lack of correlations is offered by the theory that quantitative differences in sleep may be offset by qualitative differences. If such qualitative differences exist, then sleep cannot be accurately measured in units of time alone. The observations of Gilbert and Patrick (13), who for experimental purposes went without sleep for ninety hours, showed that only a small fraction of the sleep lost (one third to one sixth) was later made up, but that the sleep which followed the experiment was much more profound than usual.

A third explanation relates to "the factor of safety." This may be sufficiently large to enable both body and mind for many years to withstand with apparent success a real and considerable sleep deficiency, while at the same time the reservoir of energy is being insidiously depleted. It would be rash to infer that a mode of life is safe merely because it does not produce immediate and evident injury. The factor of safety must be kept intact. We want not merely the strength to do the average work of each day, but we need to keep the reservoirs of energy well supplied, so that we may withstand the sieges of deprivation, disease, accident, and overwork which are almost inevitable.

In the fourth place, the lack of correlation between sleep and intelligence may be accounted for on the hypothesis that the heightened brain activity which is necessary for high-grade intellectual processes involves a kind of neural excitement which itself predisposes to wakefulness. To test this hypothesis, sleep records were secured from 383 feeble-minded individuals, from 6 to more than 60 years of age, in the Vineland Training School.[1] Figure 27 shows the results for the

[1] The writer is indebted to Superintendent E. R. Johnstone and to Dr. H. H. Goddard for supplying the records for this comparison.

193 feeble-minded children whose ages fell between 6 and 19 years. For sake of comparison the curve for our normal children is reproduced.

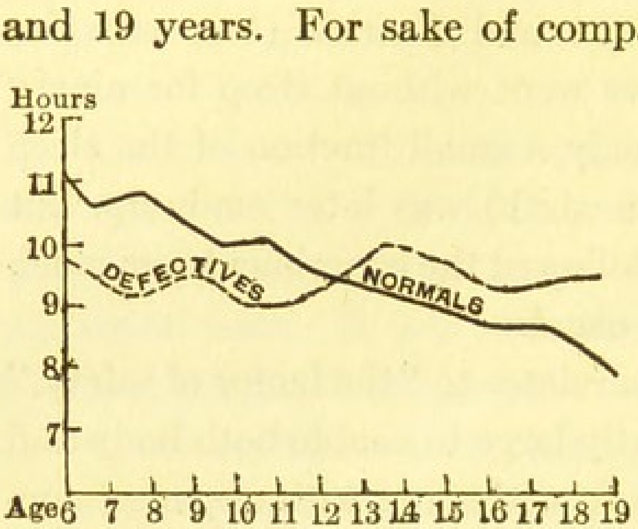

FIG. 27

Sleep of mentally defective children compared with that of normals. (Terman and Hocking.)

It is seen that the feeble-minded children sleep much less than normal children of the same age, the feeble-minded adults much more than normal adults. As regards sleep, the feeble-minded retain throughout life the characteristics of childhood. Otherwise there seems to be little relation between the amount of sleep and the grade of intelligence.

As regards the school child, in all probability, the wisest course is for us to make the conditions such that the child will sleep as many hours per day as he wants to sleep. We should avoid either abbreviating or unduly prolonging the sleep beyond this standard. Liberal allowance should also be made for individual differences. There are probably physiological idiosyncrasies which make nine hours for one child equivalent to eleven hours for another.

The conditions of children's sleep

The conditions of sleep may be roughly classified under two headings: (*a*) the external or environmental, and (*b*) the internal or individual. Under the former may be considered such matters as the following: —

(1) Housing conditions. There is probably no section of the country where crowding is less common than in the Western States; but of the 2692 children who entered into this investigation, only 32 per cent have a bedroom to themselves, while 16.4 per cent share the sleeping-room with two other persons, and 9 per cent with three or more.

(2) Ventilation. The following table reveals the bedroom ventilation of our 2692 pupils for the different ages. The first column shows that the number sleeping practically without ventilation is much smaller in the later years. This is no doubt partly the result of hygiene instruction in the school.

TABLE 35

Age	Ventilation of bedrooms			
	No window open	One open	More than one open	Open-air
6	40.6%	43.8%	12.5%	3.1 %
7	38.	52.5	8.	1.5
8	28.5	58.1	9.3	4.1
9	28.4	56.2	12.1	3.3
10	24.6	57.8	14.5	3.1
11	26.	56.4	14.5	3.1
12	19.6	63.5	13.6	3.3
13	16.6	62.	16.6	4.8
14	10.2	66.6	20.8	2.4
15	14.	69.	14.6	2.4
16	5.2	67.8	25.	2.
17	6.5	70.4	18.5	4.6
18	2.5	78.	17.	2.5

Any teacher who will go to the slight trouble necessary to make a sleep survey in her school will find enough, not only to astonish her, but to give her some valuable suggestions for the teaching of practical hygiene. In this case it was found that 47 per cent of those sleeping with no windows open were sharing the bedroom with at least two other persons!

(3) Work. Five per cent of Ravenhill's boys rose regularly before 5 A.M. for various kinds of work. Of the 6-year-old boys, 2 per cent were engaged in gainful occupations out of school hours. This rose to 28 per cent at 11 years and to 53 per cent at 12.[1] Almost any teacher in city schools above the sixth grade will find, if she takes the trouble to inquire, a certain number of pupils in her class who are engaged in remunerative labor from 10 to 20 hours per week.

(4) Hours of retiring. Nearly 5 per cent of Ravenhill's 6-year-old children retire as late as 10 o'clock, and nearly 10 per cent of her 10-year-olds. The time lost in this way cannot be fully made up in the morning because of the disturbance caused by the early rising of parents, and because of the necessity of getting to school at a given hour. In other words, the hours set apart for the sleep of children are not always those best adapted to insure a sufficient amount. Even the families who set a reasonably early hour for the children to retire usually permit so many irregularities that, as one writer puts it, "the law is more observed in the breach than in the performance." Ravenhill found

[1] In our own study the returns on this point were unreliable because of an unfortunate wording of one of the questions.

that 20 per cent at 6 years, and 40 per cent at 13 years, were allowed one or more irregularities per week. The European custom of beginning school at 7 to 8 o'clock in the morning works great hardship, often causing the pupil to rush away to school in nervous haste and without breakfast. Nine o'clock is far better.

(5) Vermin. Medical examiners sometimes find from 10 to 40 per cent of the pupils of a school affected with vermin. Needless to say, the child who is so tormented cannot secure normal sleep. Other parasitic diseases, such as scabies ("itch"), ringworm, and intestinal worms, should be mentioned in this connection.

(6) Miscellaneous conditions. The sleep of school children is influenced in many other ways. Temperatures much above 60 degrees are unfavorable both to quantity and quality of sleep; hence children sleep more in the winter than in summer. The late sunrise of winter mornings exerts an influence in the same direction. Humidity and atmospheric pressure are other factors, though their exact effects have not yet been determined. Some children sleep poorly for lack of a bed or because of insufficient protection from cold. Still others are aroused by the din of early street noises.

Internal conditions influencing sleep

Improper diet is one of the most important of these. The child's sleep may be disturbed by excess of starchy foods, unsuitable cooking, etc. The late dinner, following an inadequate breakfast and cold unsatisfying noonday meal, favors engorgement of the stomach, and is therefore unfavorable to sleep.

The influence of tea and coffee upon sleep is a matter of common observation. The experiments of Hollingsworth (8) on ten men and six women, extending over a period of forty days, verify common opinion on this point, and show further that the influence of caffeine is in inverse proportion to the weight of the subject. One cup of coffee for the 7-year-old child is therefore equivalent to three cups for the average adult. Even this may understate the facts, since it is probable that the child's body does not adjust and become habituated to the evil effects of drugs as well as the body of the adult. Dr. E. B. Hoag finds, from questioning many thousands of school children, that about 80 per cent drink coffee or tea daily, and that many young children drink from three to six cups daily. Hundreds of thousands of school children in the United States are kept in a constant state of semi-intoxication by the use of coffee and tea.

The nervous child is notoriously a bad sleeper. Such a child is likely to be obsessed by fears, tormented by absurd pangs of conscience, excited by an over-active intelligence, or worried by trivial happenings which would be forgotten by the normal child in a few minutes. Religion-bred fears, fear of the dark, and vague indefinable anxieties haunt the evening hours of more children than most of us suspect; for children learn that it is pleasanter to bear many a secret pain and sorrow than to hazard reproof and misunderstanding by imparting them to unsympathetic elders.

Home study robs many a nervous child of the needed margin of sleep. It not only causes him to remain up later, but is likely to induce an excited condition of mind which is followed by superficial and disturbed sleep. Arithmetic lessons are especially unsuited for home assignments, but because of their quality of definiteness they are just the kind of homework with which children are most likely to be burdened.

Other common causes of disturbed sleep are obstructed breathing, eye-strain, dentition, earache, toothache, etc.

In children over eight years of age night terrors are a common disturbance. They are occasionally provoked by indigestion, obstructed breathing, or other reflex irritations, but in most cases of chronic recurrence they are associated with other hereditary nervous taints, notably migraine. The condition is then indicative of general nervous instability. The child who suffers from night terrors deserves special oversight on the part of parent, teacher, and physician. Often it is wise to remove such a child from school.

Teaching children to sleep

That only 3.1 per cent of the school children in the mild and equable climate of California enjoy open-air sleeping-rooms suggests what remains to be done in this line of instruction.

The teacher should know the poor sleepers in her classes and those who suffer night terrors or other fears and obsessions which interfere with sleep. She should know which children drink coffee, tea, and beer; which ones sleep in crowded and ill-ventilated bedrooms. By means of a series of questions the teacher ought every year to make a *sleep survey* of her pupils.

Suggestions for a sleep survey of school children

1. What time do you usually go to bed?
2. How many times per week do you go to bed later than this? How much later?
3. How long does it usually take you to go to sleep?
4. At what hour do you usually wake?
5. How many times a week do you sleep later than this? How much later?
6. Does some one wake you (call you) in the morning?
7. Do you ever have dreams that frighten you? How often? What are they usually about?
8. Are you afraid to sleep in a room alone?
9. How many *other* persons sleep in the same *room* with you?
10. How many *other* persons sleep in the same *bed* with you?
11. How many windows are there in your bedroom?
12. How many windows did you have open last night?
13. How wide were they open?
14. Do you sleep in an ordinary room, or out of doors, or on a sleeping-porch?
15. Do you study your lessons at home? What lessons? What time in the day or night do you do home study? How many minutes or hours of home study each day?
16. Do you take private lessons (that is, out of school) in music, painting, etc.? If so, how much time does this take each day?
17. Have you regular work to do outside of school, such as

selling papers, doing chores, helping parents, or anything else of this kind? If so, how much time does it take each day?

To avoid the possible effect of suggestion, it is necessary to give the questions without previous discussion of any kind. All remarks regarding the desirability of bedroom ventilation, sufficient sleep, etc., should be postponed until after the answers have been secured. If this precaution is not observed, the children are likely to shape their answers to please the teacher, instead of giving facts. It is best to distribute mimeographed copies of the questions for the children to answer in writing.

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CHAPTER XXI

SOME EVIL EFFECTS OF SCHOOL LIFE

THE school is a formal agency devised for the purpose of bringing the child into possession of the main body of our social inheritance, — the treasures of knowledge, culture, and skill laboriously accumulated by countless generations of ancestors. When these treasures were few and pertained mostly to the affairs of immediate self-preservation, there was little danger of overburdening the young in the process of their acquisition. To-day the case is different. The intricacy of present-day civilization has raised mountains of difficulties which must be met and overcome by all children who are not to become playthings of complex social and industrial forces. The period of infancy has not lengthened in proportion to the increased educational demands upon it. The school term has been considerably lengthened, and for the first time in the world's history attendance has been made generally obligatory.

That this situation involves certain physical dangers to the child is self-evident. Indeed, the charge of school overpressure has been made repeatedly for at least half a century. The complaints have come chiefly from physicians, professors of pedagogy, educational theorists, and parents; only occasionally from the school itself. Because of the wide variations in the severity of the school's demands upon its pupils, and because of the individual differences in the ability of children to meet these demands, it would be misleading to give a categorical answer to the question of overpressure.

Every one will admit, however, that injury is sometimes inflicted upon the child by the activities and environment of the school. Almost every chapter in the present volume has presented evidence of such injuries. At the same time, the school is usually only one of several factors involved, and it is often impossible to determine with certainty the exact share of each in the production of the ill health which has been found so prevalent among school children everywhere. That the school is one of the important causes is evidenced by the results of many investigations.

The school as a cause of morbidity

Hertel's pioneer study (10) of the health conditions and work habits of 3141 boys and 1211 girls in the secondary schools of Denmark revealed what was then regarded an incredible amount of morbidity, and demonstrated sufficient correlations of morbidity with years of school attendance and with daily hours of study forcibly to suggest a cause-and-effect relation. In the first two classes (children 8 to 10 years), the percentage of morbidity was only 18.4; that is, 18.4 per cent were suffering from one or more chronic defects serious enough to impair health. By the end of the third year the amount rose to 34 per cent, and by the end of the eighth year, with its average of $8\frac{1}{2}$ hours of daily study, to nearly 50 per cent. The pupils whose studies were chiefly of a scientific nature showed a decidedly lower percentage of morbidity than that found among the students of classical courses. This was thought to be due to the heavier demands of the classical courses upon intellectual application and to the smaller opportunity afforded for physical activity. Conditions were even worse among the girls, among whom morbidity rose from about 30 per cent in the first two grades to over 60 per cent by the age of 12 to 16 years. The suspicion is justified that the daily period of study, which increased concomitantly from about seven to about nine hours, may have been causally related to the increase in morbidity.

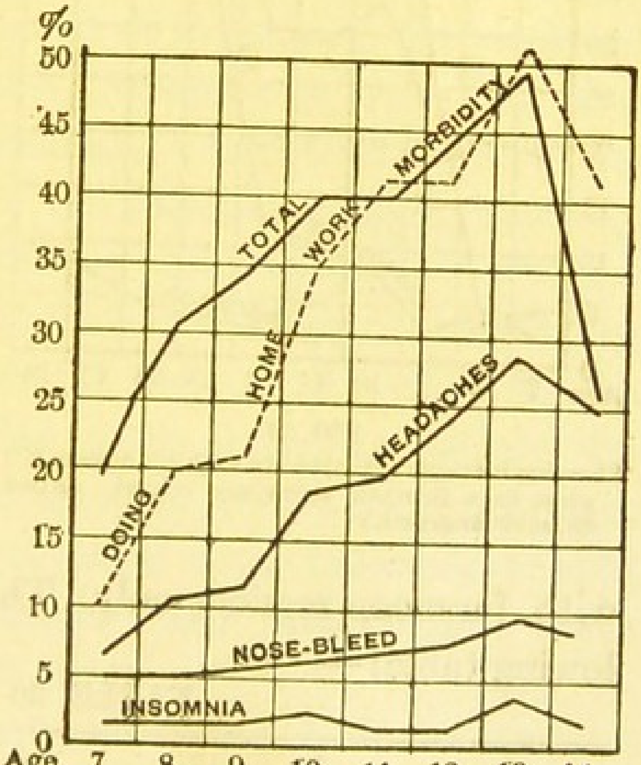

FIG. 28

Showing increase of morbidity with age among 1900 girls in German middle schools. (After Schmid-Monnard.)

The later study, made by Schmid-Monnard (19), of 5100 boys and 3200 girls in the secondary schools of Germany, confirmed essentially all the findings of Hertel. The above figure from Schmid-Monnard shows

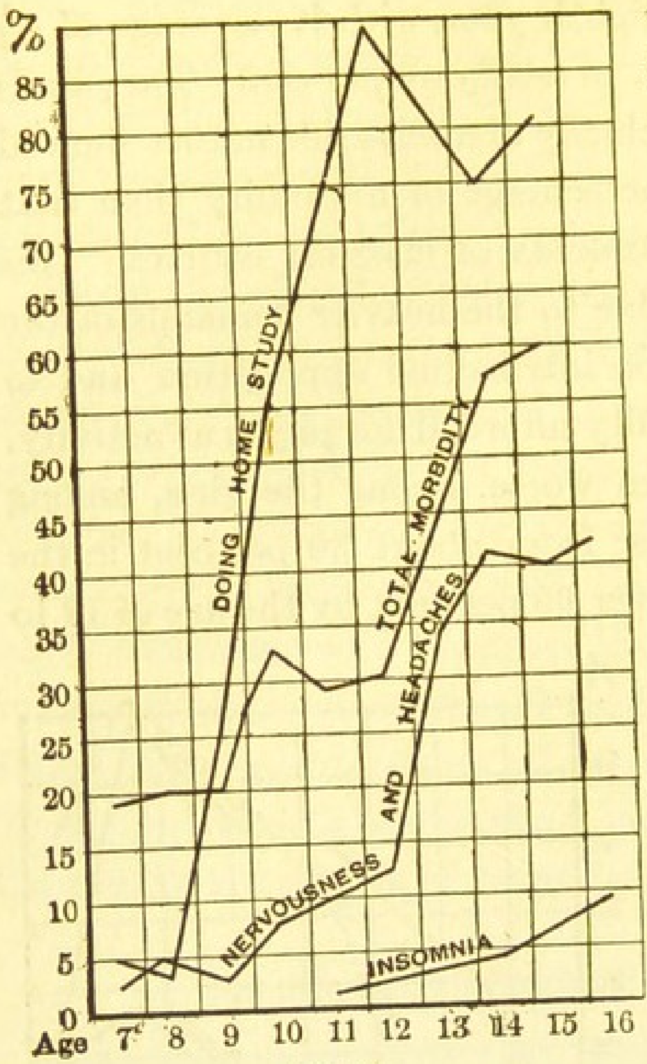

FIG. 29

Showing increase of morbidity with age among 500 girls in a German secondary school. (After Schmid-Monnard.)

the rise in morbidity among 1900 girls in a middle school and the corresponding increase of frequency for headaches, insomnia, and outside employments.

Figure 29 shows similar correlations for 500 pupils in a girls' higher school.

Roughly speaking, schools with both morning and afternoon sessions showed in the higher grades nearly twice as much morbidity as schools with forenoon sessions only. This is shown in the following table: —

TABLE 36

	Morning session only		Morning and afternoon sessions	
	Average	Maximum	Average	Maximum
Total morbidity	25%	39%	50%	74%
Nervousness and Headaches	13.	28	25	62
Insomnia	1.5	5	4	19

Both Hertel and Schmid-Monnard found that the percentage of morbidity rises considerably toward the end of the school year. Mortality also slightly increases for a brief period after school entrance; likewise the incidence of infectious diseases.

The American study of high-school pupils by Johnson (14) showed that those pupils who were not well were generally the ones who studied most, took most private instruction, and slept least.

The most extensive and important single investigation of this kind yet made is that carried out by the Russian Department of Education, the results of which were reported by Khlopine in 1911 (13). This investigation was essentially a health census of all the secondary schools of the Russian Empire, carefully and uniformly carried out under the direction of the Chief Medical Officer of Schools. The census was taken in 1905–06, and included about 116,000 out of the 139,000 pupils enrolled in the secondary schools. Its main purpose was to establish the incidence for age, grade, sex, and type of school of the following defects: myopia, spinal curvature, nasal hemorrhages, headaches, and nervous troubles.

The following chart, which has been constructed from the numerous tables given by Khlopine, presents a summary of his results in so far as they throw light upon the correlation between physical defectiveness and the length of school attendance.

Khlopine's data show that the frequency of myopia varies only very slightly according to sex; that it increases gradually from eastern to western Russia and from smaller to larger cities; and that it is higher in the technical than in the classical or modern-language schools.[1]

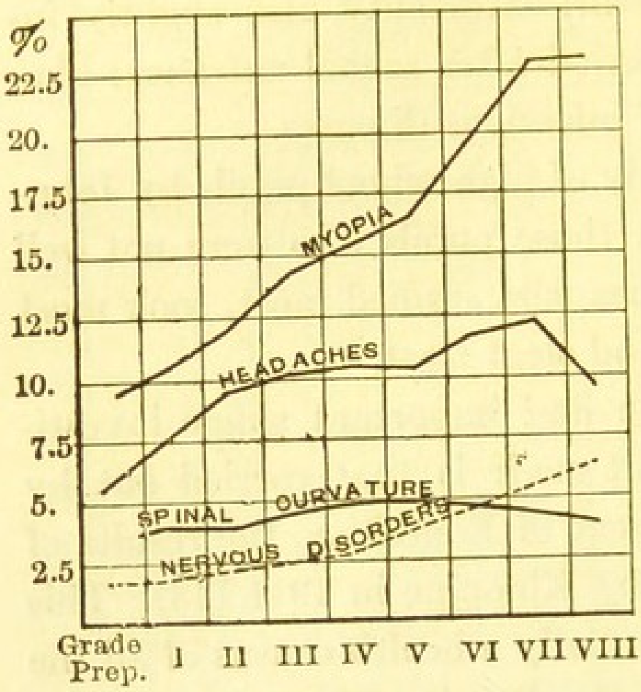

FIG. 30

Showing percentage of certain defects according to grade for pupils in the secondary schools of Russia. This chart summarizes one of the most important investigations of this type. (After Khlopine's tables.)

Nasal hemorrhage is caused in part by the congestion of blood about the head resulting from the forward inclination of the body in reading and from the intellectual and emotional tension of school life. Nasal hemorrhage is not ordinarily a summation effect from long-continued unwholesome conditions. If it does not appear in the lower grades it is not likely to appear at all. This tends to conceal its dependence upon school life: but that this dependence is none the less real seems to be demonstrated by the following table from Khlopine showing the relative infrequency of nose-bleed in the technical schools: —

[1] The influence of the school in the production of myopia is now known to be much less than it was formerly believed to be. It is one factor, but not the leading one. See chapter XIV.

TABLE 37

	Type of School	Frequency of nasal hemorrhage
Boys'	Classical schools	3.2 per cent
Boys'	Modern-language schools	2.7
	Girls' schools	3.1
	Technical schools	1.7

This difference in favor of the technical schools exists in spite of their excessively heavy program, and may be due to the greater amount of physical activity which they permit as compared with other schools.

For spinal curvature, the figures given show an increase of only about 50 per cent from the first to the sixth grade, but it is by no means clear that this tells the whole story. It is possible that but for the unhygienic postures assumed by the school child the incidence of spinal curvature would show a fall at the close of the period of accelerated adolescent growth.

Headaches double in frequency from the first to the seventh grade; (other) nervous troubles increase nearly fivefold. The significance of these and related symptoms has been set forth at some length in chapters xv to xviii. Khlopine seems well justified in concluding that the school must be conducted in strict accordance with the best standards of school hygiene, and that its medical service must be improved, if it would avoid the danger of injuring the health of its pupils.

That we are not able to marshal as convincing an array of incriminating evidence against the schools of our own country is due more to the lack of data than to the absence of school injury. As far as evidence is available, it points to conditions of morbidity not greatly different from those existing in the schools of Russia, Germany, Denmark, and Sweden.

The effects of school life upon growth

Schmid-Monnard sought to ascertain the influence of school life on the body by comparing the growth attained during the seventh year of life by children in the school with that attained in the same year by children who had not entered school. The results, as shown in Table 38, indicate that school entrance brings a shock to the nervous system of the young child severe enough to retard growth.

TABLE 38

	Growth in weight — expressed in kg.		Growth in height — expressed in cm.	
	Boys	Girls	Boys	Girls
Pupils not attending school	2.2	1.9	7.4	5.6
Pupils attending "	1.5	1.6	4.2	4.5
Difference in favor of former	.7	.3	3.2	1.1

Engelsperger and Ziegler (7) weighed about 500 children, 5 to 6 years of age, on entering school, and again two months later, and found that 20 per cent had lost weight. This loss occurred at just that season of the year when growth in weight is normally most rapid. All should have gained. The retarding effect was most marked in the youngest pupils, those under 6 years of age. The authors conclude that entrance before 6 years should never be permitted and that many pupils ought not to enter school before the age of 7 or 8. Quirsfeld (18) followed the growth of 1014 children through the first four years of school life and found that 46 per cent failed to gain weight during the entire first school year, while 21 per cent showed an actual loss. The number failing to gain during the second year was only 10 per cent, the third year 8 per cent, and the fourth year about 6 per cent.

Wretlind's measurements of 3647 children, aged 7 to 17, showed that the average gain in height for the three months of summer vacation ranged from 30 to 80 per cent as great as that for the entire nine months of the school year.[1] Whether seasonal influences alone were responsible for this difference, or whether a part of it was due to the cessation of the school, we do not know.

Binet in France and Schuyten in Belgium sought to determine the effect of school life on the child by ascertaining the changes in appetite during the school year. The quantity of bread consumed in the daily school meal was used as a general index of appetite. On the basis of exact records showing the amount consumed each day for a school year, both investigators state that the consumption of bread diminishes during the course of the year, and conclude that intense intellectual work injures the appetite.

In another study, Schuyten has attempted to ascertain by a more direct method the effect of the school

[1] Quoted in reference 17 to chapter III, this book.

upon the child's state of nutrition (22). By use of the Oppenheimer formula for determining nutrition,[1] Schuyten made a study of 1100 boys, 3 to 14 years of age, and 300 girls, 3 to 6 years of age, for the purpose of finding any relation that might exist between the state of nutrition and the length of school attendance. For statistical purposes the pupils were grouped according to age by half-years, 50 in each half-year.

The results are stated as follows: "The nutrition coefficient of girls attending the kindergarten drops from the third to the sixth year.[2] That of the boys drops throughout the classes from the third to the eighth year, rising again somewhat up to ten years, and remaining constant at this lower value up to fourteen. . . . The condition of nutrition found at the onset, which is excellent, does not return." After losing severely in energy of nutrition and assimilation up to the eighth year, it appears that the child's body partially adapts itself to the new régime. Up to the fourteenth year, however, there is inability to reach their original excellent condition.

Effects upon the appetite, nutrition, and the composition of the blood

One of the evils most often blamed for school overpressure is the formal examination. In 1896, Serafani discovered that examinations caused a marked reduc-

[1] $\frac{\text{Girth of arms} \times 100}{\text{Chest girth}} = \text{nutrition coefficient.}$

[2] Girls older than 6 were not examined.

tion in the amount of nourishment taken by university students, and a corresponding decrease of weight. His conclusion was to the effect that prolonged examinations tend to bring about a condition of the nervous system strongly resembling that of neurasthenic persons.

Ignatieff (11) made a study of the physical effects of examinations on 242 pupils, 10 to 16 years of age, in a Moscow military school. The pupils were weighed just before they began preparation for the examinations, again at the close of the examinations, and finally after the close of the ensuing $3\frac{1}{2}$ months of vacation. Comparing the second weighing with the first, we find that 79 per cent had lost weight, about 11 per cent had not changed, and only 10 per cent had made any gain. Since the examination and the preparation for it extended over a period of from one to two months, and since the pupils were at an age where growth from month to month is normally very rapid, all should have gained. As it was, those of the lowest grade lost on an average 2 per cent of their weight; those of the highest classes over 3 per cent. Quite different is the result when we compare the third weighing (after vacation) with the second (before vacation), for here we find loss of weight with only 4.6 per cent and gain with 90 per cent. For 13 pupils, the extended vacation was not sufficient to make up the loss of weight suffered during the strenuous pre-vacation period. Ignatieff concludes that in its physical effects, the extended examination is comparable to a severe illness, and that a mental strain severe enough to cause such marked alterations in metabolism could hardly fail to affect unfavorably that organ most concerned in the overpressure, — the brain itself.

Koginoff, in a similar experiment, found a loss in weight among 75 per cent of the pupils concerned. He states that the remaining 25 per cent who were not so unfavorably affected were either lazy or of optimistic temperament.

This point deserves emphasis. The child of nervous temperament, who worries easily, is extremely liable to suffer from overpressure. Worry acts both as cause and effect, and fosters a vicious circle of influences.

Data of this kind lead us to infer that the intensive nervous stimulation involved in excessive mental work produces its injury through its reflex effects upon the nutritional processes and upon sleep. Graziani, however, has raised the question whether there may not be unfavorable influences more direct than that involved in this explanation. These he believes are of two possible kinds: (1) Imperfect oxygenation of the blood and incomplete elimination of carbon dioxide due to the superficial respiration which has been proved by Mosso, Macdonald, Bush, Obici, and others to result from application to mental tasks; and (2) an immediate effect upon the chemical composition of the blood corpuscles due to the accumulation of fatigue toxins resulting from mental work.

In order to test the latter theory, Graziani subjected 18 university students and 17 children of 10 to 12 years of age to blood tests before and after the preparatory period for school examinations. The tests involved three determinations: the number of red corpuscles, the relative proportion of hæmoglobin which they contained, and their power of resistance. In regard to the number of corpuscles, no constant differences were found either with university students or children. The proportion of hæmoglobin, however, showed a decided decrease, amounting to 10 per cent with the students, and to 7.4 per cent with the children. The effect upon the power of resistance of the red corpuscles was much the same as other investigators had shown to result from weak poisons. Graziani, therefore, concludes that intellectual work probably produces a toxin which brings about an immediate change in the chemical and functional properties of the blood.

To try this theory still further, Graziani subjected himself and a 12-year-old boy to the same kind of blood examinations, except that in this experiment the blood tests were separated only by a number of hours of strenuous mental work instead of many weeks, as was the case in the earlier experiment. Here, again, the decrease of hæmoglobin was marked, amounting to 7.5 per cent with Graziani himself and to 8 per cent with the boy. The experimenter concludes that the underlying cause of school anæmia, with its alterations of metabolism and its imperfect oxygenation of the blood, is to be sought in the influence of excessive accumulations of toxic products of fatigue.

Another important study of the same type, made by Dr. Helwig (9), entirely corroborates the findings of Graziani. This author made many blood tests upon himself and six other subjects for the purpose of determining the influence of school work, fresh air, rest, marches, and lessons of different degrees of difficulty, both upon the number of red corpuscles and upon their "degenerative" and "regenerative" processes. The study seems to have been made with the most approved technique and with due regard for scientific accuracy.

The results were rather variable for the corpuscle count, but for the "degenerative" and "regenerative" processes they were strikingly uniform.

As a result of school work, the "disintegration quotient" was increased 29 out of 33 times. The author holds that the study "distinctly" demonstrates that school work not only imposes a strain upon the nervous system, but that it also produces a destructive effect on the blood corpuscles. The numerous tables presented by the author show the influence of the following factors upon the condition of the blood: the difficulty of the school work, the length of the work period, the frequency of the recitation intervals, the amount of exercise, and the access to fresh air.

Helwig concludes that "arduous mental work produces unfavorable changes in the blood; that recuperation is marked by the elimination of waste products and by a more or less active regeneration of corpuscles." Observation of the children showed that "external manifestations of fatigue invariably accompany the microscopical phenomena associated with this state."

It was not only from highly sensitive children that reactions were obtained. The author observed the same phenomena in his own person after long-continued mental strain. "While a considerable degree of corpuscle disintegration could be noted in the morning after several weeks of concentrated sedentary work indoors, accompanied by physical depression, lassitude, and heaviness, this phenomenon disappeared, together with the subjective symptoms, after a walk of two hours. On another occasion, the disintegration quotient increased considerably after four hours' incessant work at the microscope prior to taking food and following a prolonged period of close application to research work, but decreased rapidly after two hours' devotion to a totally different occupation and after lunch taken in the open air." Rest days showed an immediate effect on the disintegration quotient. Long and tiring marches produced only small degenerative values and were followed by rapid regeneration. During a day of mental work disintegration continually increased until late in the afternoon, indicating that this part of the day is least suitable for hard study.

The reverse phenomenon, the improvement which takes place in the composition of the blood as the result of a well-spent summer vacation, has been dealt with experimentally by Borchmann (4), who gave blood tests to 19 boys and 18 girls of Moscow before a two months' "summer colony" outing and again after their return. The second test revealed an average gain of nearly a million red corpuscles per cubic millimeter of blood and a marked increase of hæmoglobin. This is shown in the following table: —

TABLE 39

	Boys		Girls	
	Red corpuscles per cubic mm.	Percentage of hæmoglobin	Red corpuscles per cubic mm.	Percentage of hæmoglobin
Before vacation	3,884,000	73.1	3,760,000	69.6
After vacation	4,820,000	79.2	4,480,000	78.3

Borchmann also tested eight of the girls two months after their return to school, and found that in three the number of red corpuscles had still further increased about a quarter-million per cubic millimeter, while in the other five there was a decrease of about two thirds of a million as compared with the second count. But in no case was the condition as unfavorable as before the vacation. The hæmoglobin had in some cases decreased 5 per cent below the second showing; in others had increased; but in all cases it surpassed the pre-vacation record. Leuch had already secured similar results for children of Geneva, and the work of both is strikingly corroborated by blood tests of children who have been transferred from unhygienic conditions of the ordinary classroom to the open-air school.[1]

[1] See chapter on open-air schools in *Health Work in the Schools*, by Hoag and Terman. Houghton Mifflin Co.

The effects of school postures on respiration

The effects of school occupations on the respiration have been studied experimentally by Oker-Blom (17) and by Badaloni (2). The latter secured kymographic records showing variations in the depth of respiration in the upper part of the lungs resulting from different postures assumed in writing. It was found that the asymmetrical position induced an inflexibility of the upper part of the chest and caused decreased depth of respiration in the upper part of the lowered side. Later, Binet raised the question whether this may not be compensated by simultaneously increased abdominal breathing. In a second study, Badaloni was able to prove that no such compensation takes place. His records show that the asymmetrical position brings a "remarkable decrease" in the expanding capacity of the upper chest. The symmetrical sitting posture, even when the sternum was allowed to touch the desk, showed a less injurious effect. The author concludes that the asymmetrical position, even more than the sitting posture, *per se*, is responsible for the school's evil effects upon the lungs. He believes that the school is in this way an important cause of tuberculosis.

In 1911, Oker-Blom (17) reports a similar experimental study of respiration, carried on with 25 pupils during different school occupations. The most marked difference found was that between standing and sitting. The decrease in total respiration for brief sitting (3 minutes) was about 8 per cent, and for longer periods

(12 to 39 minutes), 50 per cent. Interesting differences appeared with different kinds of school work. Knitting, for example, showed an impeding effect upon the respiration of the upper left lung 18 per cent greater than did reading aloud. In agreement with the results of Badaloni, the greatest impediment to respiration was found in the upper part of the lowered side of the chest. This, in turn, increases the asymmetrical condition and helps to explain why scoliosis sometimes runs a progressive course. Oker-Blom concludes that all kinds of school activities, including hand-work, should be frequently alternated with change of position and with physical exercises.

Psycho-pathological effects of school life

There is reason to believe that the intellectual apathy of older children and adults is sometimes due to school over-dosage or to other kinds of educational malpractice. It has often been charged that the school has a depressing effect upon the child's spontaneity; that it mechanizes his mental processes, and destroys the individualistic elements of his personality.

The depressing and inhibitory effects of school upon the child's mind are of such a nature that their objective measurement is of course very difficult. An attempt at such measurement has been made, however, by the Belgian psychologist, Schuyten. The investigation in question was undertaken on the assumption that the supposed unfavorable influence of the school would probably be revealed in the character of the child's spontaneously controlled drawings. Accordingly, 200 children of each age (100 boys and 100 girls), from 3 to 13 years, were asked to make a "drawing of a boy." The direction was given orally and without explanation or suggestion, everything being left to the

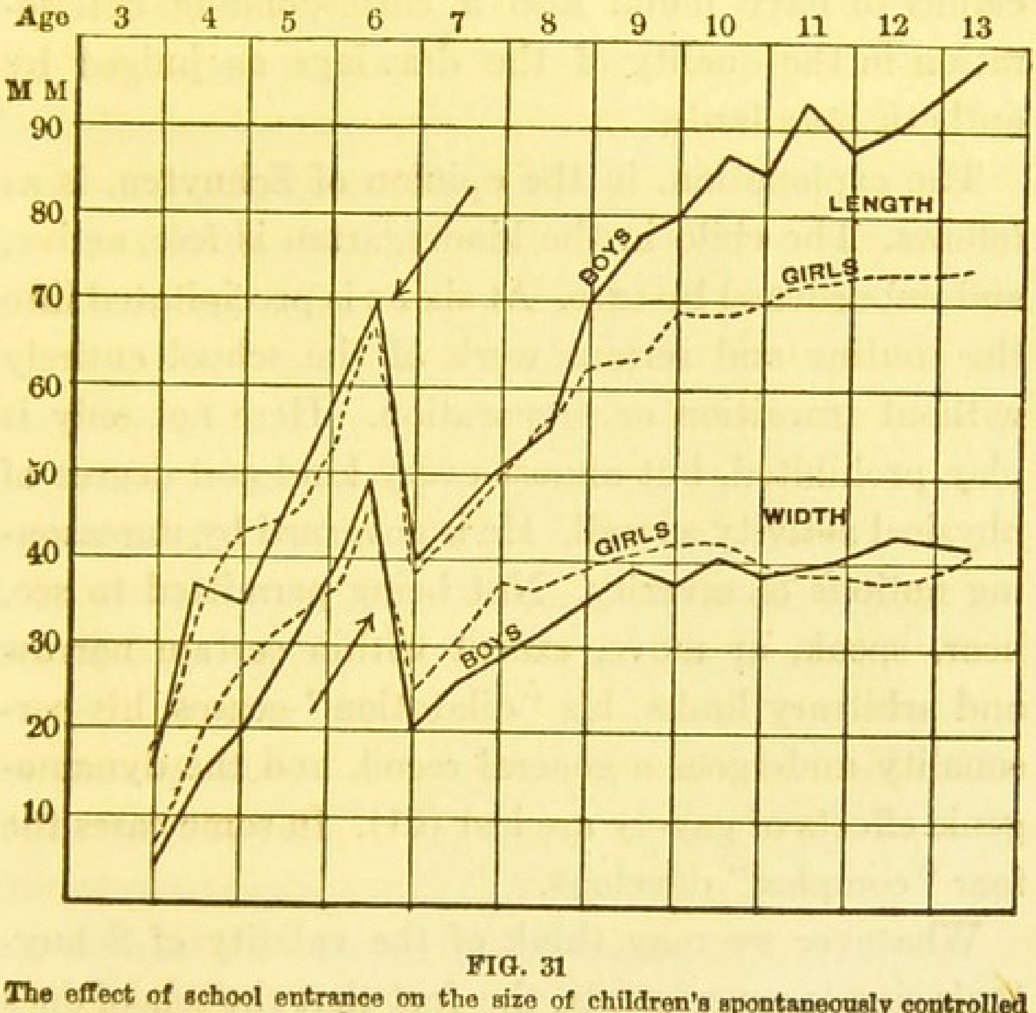

FIG. 31

The effect of school entrance on the size of children's spontaneously controlled drawings. (After Schuyten.)

spontaneity of the child. The blank sheets of paper and pencils supplied were of uniform size and material. The drawings thus secured were measured in length and width for the purpose of ascertaining age differences. The results are embodied in the accompanying figure.

It is seen that the child's entrance into the school brings an almost immediate decrease in the size of his spontaneous drawings; that the pre-school norm for width of drawing is not again reached by either boys or girls, and that the pre-school norm for height is reached only after two and a half years. Schuyten claims to have found also a corresponding deterioration in the quality of the drawings as judged by æsthetic standards.

The explanation, in the opinion of Schuyten, is as follows. The child in the kindergarten is free, active, and unburdened by care. At six he is precipitated into the routine and serious work of the school entirely without transition or preparation. Here not only is play prohibited, but almost every kind and degree of physical activity as well. He is governed by unreasoning notions of severity. Not being permitted to see, hear, speak, or move, except within certain narrow and arbitrary limits, his "dilatation" ceases, his personality undergoes a general recoil, and the dynamogenic effects of gayety are lost (21). In some cases the fear "complex" develops.

Whatever we may think of the validity of Schuyten's simple experiments, the fact that the school does not always develop self-reliance and the power of independent thinking is conceded by every one. How to carry on the routine work of the school without deadening the native intellectual interests and curbing overmuch the child's personality is a problem whose solution must be sought anew by every generation of teachers.

The annual accumulation of fatigue

Several investigations indicate that mental fatigue accumulates during the school year. Schuyten, for example, conducted for an entire school year a series of fatigue tests by means of the esthesiometer upon 11 boys and 10 girls. The tests were given daily during the first week of each school month and the results for the different months were then compared. Preliminary tests to accustom the children to the experiment had been given for two months at the close of the previous school year. The accompanying curves show the average month by month decrease in sensitivity of the skin of boys and girls for the second year.

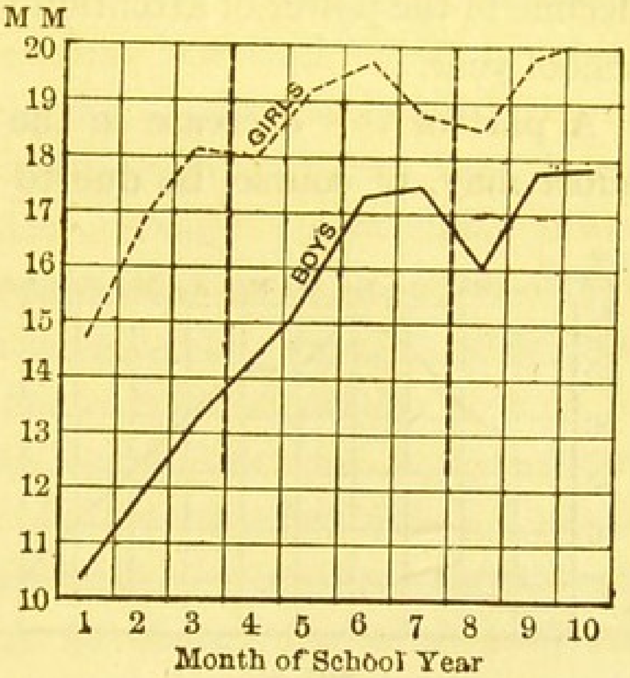

FIG. 32
The annual curve of fatigue in school children as measured by the esthesiometer. Greater vertical distance means decreased sensitivity of the skin. The two vertical dotted lines represent brief vacations. Note their effect on curves. (After Schuyten.)

In another series of experiments Schuyten gathered important evidence of the deterioration which the voluntary attention of children undergoes under various influences. His attention test, which consisted of a five-minute reading lesson, was given four times daily (at 8 and 11 o'clock in the morning and at 2 and 4 in the afternoon), for an entire school year to the pupils of 16 classes. Besides demonstrating a decline of attention from 8 to 11 in the forenoon and from 2 to 4 in the afternoon, the results, as graphically represented in the following curve, demonstrate an astonishing decline in the power of attention toward the end of the school year.

A part of this decrease in the power of voluntary effort may, of course, be due to the influence of the higher temperature of the spring and summer months. This is indicated by the upward slope of the curve during the autumn. At the same time, in the light of supplementary evidence from other fatigue studies, it would be unreasonable to explain the curve entirely on the temperature theory. Lobsien, in a lengthy series of memory tests, has found a similar decline in the memory ability of children during the school year.

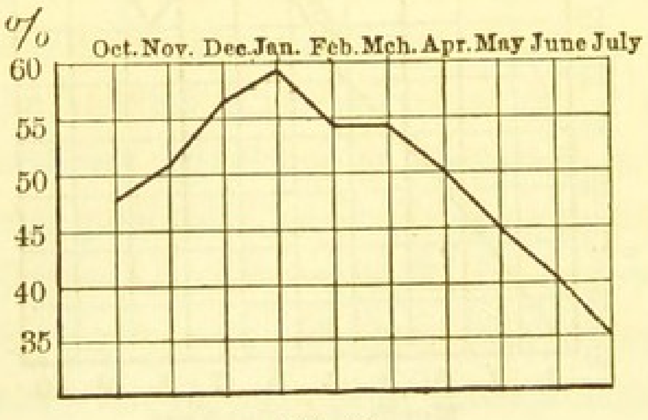

FIG. 33

Showing curve of mental fatigue during the school year as measured by Schuyten's attention test. Vertical distance represents the percentage of children, whose attention *did not fail* during the test.

It is well to emphasize that inattention is more than a mere index of mental efficiency. Its function is also a positive one; it is a protective agency, designed to conserve the deeper levels of energy from too complete exhaustion. It is a beautiful and necessary adaptation of nature that the psychophysical organism accumulates stores of energy which it refuses to draw upon except under the greatest provocation and at moments of unusual stress. This is the *factor of safety*, which it is the function of sleep, inattention, and other rest states to conserve. Inattention is, therefore, an indispensable factor in mental economy — not a moral fault, but a safety-valve. Teachers should learn to respect it.[1] Kraepelin has even suggested that "poor teachers are a hygienic necessity"; that highly interesting instruction continued for six or seven hours a day would inevitably bring about a condition of fatigue in excess of the limits of safety.

Disturbance of the motor functions is one of the common symptoms of nervous exhaustion. Toward the end of the school year automatisms increase in number, the liability to chorea increases, postures become more faulty, loss of tone in the ciliary muscle makes "latent" hyperopia or "latent" astigmatism "manifest." The loss of muscular tone is especially evident in the aggravation of speech defects. (See chapter xx.)

Without doubt, the evil effects of school life would be more often observable were it not for the plasticity of growth which enables children, like the guinea pigs in the experiment of Professor Minot, to repair many kinds of physical damage. Nevertheless, in spite of

[1] In Triplett's study of *The Faults of Children*, "inattention" headed the list in the frequency with which it was named by teachers as the "greatest fault of children."

the child's wonderful power of rebound, we have found unmistakable evidence of the injurious effects of the school. *The close correlation of morbidity with years of school attendance, with length of daily program, and with the progression of the school term; the deterioration of attention toward the end of the school year; the damaging effects of strenuous school activities upon appetite, digestion, metabolism, and the constitution of the blood; the ill effects of deprivation from fresh air and from healthful physical exercise; the impairment of nervous coördinations and the profound disturbances reflexly produced by worry — these and other injurious effects have been sufficiently attested to justify the most vigorous prosecution of reform in matters of educational hygiene.*

Some of the worst consequences are either deferred, or else are of such intangible character that they are not apparent to common observation. In the former class belong the sedentary habits instilled by the many years of school life. These remain with most of us as an unclosed debit account, exacting throughout life a progressively usurious toll of health and happiness.

It is not claimed, of course, that school life is detrimental to the health of all children. Fortunately the exuberance of vitality is so marked a characteristic of childhood and youth that many escape without having suffered observable injury. It is the child of somewhat less than normal resistance who breaks under the pressure.

Nor are the evils which do exist beyond remedy. There is no reason why the school should not be as healthful in its influence upon both body and mind as the most perfectly ordered home. Until it approximates this ideal, the campaign for school reform should continue.

By proper attention to schoolhouse construction, and to heating, lighting, ventilation, and sanitation; by the multiplication of open-air schools; by a thorough and universal system of medical supervision; by reducing seat work to a minimum so as to give more time for manual activities and play; by completely eliminating home study below the high school and by rigidly limiting it to one or two hours thereafter; by observing the laws of fatigue in the school day; by the substitution of freedom for the atmosphere of repression; by making the cultivation of physical and mental health as much its aim as the imparting of knowledge, the school can avoid all the injuries we have mentioned, and others. Until all of these reforms have become general, the school will continue to mingle evil with the good it accomplishes.

Types of children who are sometimes injured by the work or environment of the school

1. Children who are poorly fed.
2. Anæmic children.
3. Those with chronic indigestion.
4. Children with tendency to constipation.
5. Children with tubercular tendencies.
6. Children with obstructed nasal breathing.
7. Children whose muscular development is weak.
8. Children whose vision is defective.

9. Children with much outside work to do.
10. Children of unusual talent in some line. (Talent crushed by pressure of other work.)
11. Children of general mental superiority. (Held back by the lock-step of the school.)
12. Children of sub-normal mental endowment. (Disheartened by failure and repetition of work.)
13. Normal children whose development is merely belated.
14. Nervous children, including: —
    (*a*) those with tendency to chorea;
    (*b*) those who stutter;
    (*c*) those who suffer disturbed sleep;
    (*d*) those subject to headaches;
    (*e*) those who are abnormally timid;
    (*f*) those who are oversensitive to praise or blame;
    (*g*) those of neurasthenic tendency;
    (*h*) the morbidly precocious;
    (*i*) children who are over-imaginative and need the corrective furnished by contact with *things* rather than with *books*.

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22. Dr. M. Schuyten: "Rapport sur l'inattention; ses causes, ses remèdes." *Inter. Mag. Sch. Hyg.*, 1910, pp. 503–09.
*23. Dr. M. Schuyten: *The Nutrition Coefficient of Antwerp School Children.* Summary by the author, in *School Hygiene*, 1913, pp. 51–53.

(For further statistics on the prevalence of defects see other chapters in this volume; also the periodicals and all standard texts on school hygiene.)

SUGGESTIONS

FOR A TEACHER'S PRIVATE LIBRARY ON THE HYGIENE OF PHYSICAL AND MENTAL GROWTH

*1. Jessie H. Bancroft: *The Posture of School Children.* 1913, pp. 327. Macmillan Co., N.Y.

2. Louise Stevens Bryant: *School Feeding.* 1913, pp. 345. Lippincott Co., Phil.

*3. W. S. Cornell: *The Health and Medical Inspection of School Children.* 1912, pp. 614. F. A. Davis Co., Phil.

*4. F. B. Dressler: *School Hygiene.* 1913, pp. 369. Macmillan Co., N.Y.

5. David Forsyth: *Children in Health and Disease.* 1909, pp. 362. P. Blakiston's Son & Co., Phil.

6. Sir John E. Gorst: *The Children of the Nation.* 1907, pp. 297. Methuen & Co., London, Eng.

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*8. E. B. Hoag: *The Health Index of Children.* 1910, pp. 188. Whitaker & Ray-Wiggin Co., San Francisco.

*9. E. B. Hoag and Lewis M. Terman: *Health Work in the Schools.* Houghton Mifflin Co., Boston.

10. R. Tait McKenzie: *Exercise in Education and Medicine.* 1910, pp. 393. W. B. Saunders Co., Phil.

11. George B. Mangold: *Child Problems.* 1910, pp. 352. Macmillan Co., N.Y.

*12. Albert Moll: *The Sexual Life of the Child.* 1912, pp. 339. Macmillan Co., N.Y.

*13. Nathan Oppenheim: *The Development of the Child.* 1910, pp. 296. Macmillan Co., N.Y.

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*15. WALTER PYLE: *Personal Hygiene.* 1910, pp. 472. W. B. Saunders Co., Phil.

16. STUART H. ROWE: *The Physical Nature of the Child.* 1899, pp. 207. Macmillan Co., N.Y.

*17. E. W. SCRIPTURE: *Stuttering and Lisping.* 1912, pp. 251. Macmillan Co., N.Y.

18. JOHN SPARGO: *The Bitter Cry of the Children.* 1909, pp. 337. Macmillan Co., N.Y.

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[1] The books in the above list which are most likely to be of immediate help to the teacher are marked with a *.

GLOSSARY

aërate, to supply with air.
alveolar abscess, "ulcerated tooth," or "gum boil."
ambidextrous, having the ability to use both hands with equal ease.
ametropia, any kind of abnormal refraction of the eye.
anæmia, deficiency of blood, or of red corpuscles.
anthropology, the science of man.
anthropometry, a branch of anthropology which is concerned with the measurement of the human body.
aprosexia, inability to give attention.
astigmatism, a refractive error of vision due to unequal curvature of the parts of the eye.
asymmetry, want of symmetry or proportion.
atrophy, the wasting or withering of an organ or part of the body.

bacteriology, the department of zoölogy which deals with bacteria.
biennium, a period of two years.
binocular vision, the functioning of both eyes together in vision.
carious, decayed.
chorea, "St. Vitus's Dance."
choreiform, resembling chorea.
cretinism, a form of feeble-mindedness due to defect of the thyroid gland.

dementia præcox, a form of insanity which usually has its onset between the age of fifteen and forty years.
dendrites, the tree-like branches of nerve fibers extending from the nerve-cell.
dental caries, decay of the teeth.
dentine, the calcified substance that forms the main part of the tooth.
diathesis, a predisposition to certain forms of disease, as "a tubercular diathesis."
dynamogenic, tending to produce increased nervous activity.

emmetropia, the condition of the eye in which refraction is perfect.
eugenics, the science of improving the human race through application of the laws of heredity.
euthenics, the science of improving the human race

through the control of environment.

habit-spasm, an aimless and stereotyped twitching or contraction of one or more muscles of the body.

hæmatology, that branch of medical science which treats of the blood.

hæmoglobin, that part of the red corpuscles whose function is to carry oxygen.

Holmgren test, a test of color vision by use of the Holmgren worsteds.

hyperopia, "far sight."

hypertrophied, abnormally enlarged.

inhibition, the act of restraining or repressing, as to check a nervous or mental process.

kyphosis, backward curvature of the spine.

laryngitis, an inflammation of the mucous membrane of the larynx.

lisping, an imperfect utterance, like the substitution of *th* for *s* or *z*.

lordosis, forward curvature of the spine.

lymphatic, pertaining to the lymph.

mastoid, that part of the temporal bone situated directly behind the ear.

medullation, the growth of sheath covering the nerve fibers of the central nervous system.

"mental complex," an associated group of ideas submerged below the level of consciousness and producing pathological mental conditions.

metabolism, the building-up and tearing-down processes of living material.

migraine, a special form of headache.

morbidity, imperfect state of health.

moron, that grade of feeble-mindedness just below normality.

myope, a near-sighted person.

myopia, near sight.

neurasthenia, a chronic state of nervous exhaustion.

neuroglia, the supporting tissue of the central nervous system.

neurosis, a nervous disorder.

neurotic, predisposed to nervous disorders.

obsession, a fixed idea; an idea that persists in spite of effort to banish it.

oculist, a person skilled in treating diseases of the eye.

optician, one who makes or deals in optical instruments or glasses.

oral hygiene, the hygiene of the mouth.

orthodontia, mechanical treatment for correcting irregularity of the teeth.

orthopædia, the correction or prevention of deformity of the body.
orthophonia, the correction or prevention of speech defects.
otitis media, acute infection of the middle ear.
oxygenation, supplying with oxygen.

pathogenic, productive of disease.
pharyngitis, inflammation of the mucous membrane of the pharynx.
phobia, a morbid fear.
phonation, vocal utterance.
phylogenetic, pertaining to the history of the evolution of the species.
prophylaxis, preventive treatment for disease.
psychiatry, the branch of medicine that relates to mental disease.
psychoanalysis, a method of treating functional mental disorders.
psychotherapeutics, the treatment of mental disorders in general.

radiograph, an X-ray picture.
rickets, a nutritional disease of childhood affecting chiefly the bones.

scoliosis, lateral curvature of the spine.
septic, productive of putrefaction through the action of bacteria.
sinistrality, left-handedness.
sinus, a slender opening or cavity.
strabismus, cross-eyedness.

tartar, a yellowish incrustation that forms on the teeth.
therapeutics, the treatment of disease.
tic, a spasmodic twitching of muscles, especially of the face.
toxæmia, a poisoned condition of the blood.
toxin, a poisonous compound of animal, bacterial, or vegetable origin.
triennium, a three-year period.

unidextrous, having greater skill in one hand than in the other.

vasomotor, producing contraction or dilatation of the walls of vessels; as the blood vessels of the skin.
vertigo, dizziness.
vital capacity, the ratio of lung capacity to weight.

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