

STARVATION AND MENTAL DEVELOPMENT.

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It is generally accepted that the conditions of infancy and early childhood may have an effect, favorable or unfavorable, upon the entire subsequent development of the child. It has been maintained, for example, that the child learns more in the first five years than in all the rest of his life. It is seldom, however, that the arrest of mental development which may follow upon adventitious physical conditions is so well established as in the case of a boy who came under my observation at the age of sixteen years and two months. According to the physician who was in charge at the time of birth, this child, whom we shall call Elmer, was born an entirely normal infant. The mother did not nurse the child, but fed him upon one of the well-known manufactured foods for babies. He assimilated so little of this food that growth was stopped, and his body wasted away until he was little more than a skeleton. When the boy was six years of age, the family physician arrived at the conclusion that this malnutrition and arrest of development was due to starvation alone. At this time, according to the testimony of the parents and friends, the child was a suffering infant, as helpless, small, and wordless as when a month old. As soon as the cause of his condition was known, he was taken to the country and fed upon the fresh milk of one cow. The return to health was immediate and growth began soon afterwards.

When my investigation was undertaken, Elmer was well proportioned, and almost as tall and heavy as the average boy of his age. A rigid medical examination found him in excellent health. He gave no evidence of physical deformity or asymmetry. His general appearance betrayed no lack of normal mental development. His voice was normal and well modulated. His manner was pleasing and his conduct gave his parents and teachers no concern, but he was not able to do the work of the sixth school year, although he had spent five years in the public schools, one year

in a private school, and two years in the practice school connected with the School of Education of the University of Chicago.

At this point in his development I was asked to give him individual instruction as a private tutor. To assist me in my work and to determine his mental status in comparison with that of other boys of his age, I undertook a series of experimental tests. Elmer's extreme sensitiveness on the subject of his backwardness, made it necessary for me to conduct all my experiments as lessons. This fact, combined with the pressure of my university work at the time, and the early departure of his family for the summer vacation, limited the amount of data which I was able to obtain and made it impossible to apply exact methods in some experiments. The mode of procedure employed determined: 1. His ability to receive impressions, to remember and correlate his past experiences, and to express himself; 2. What he had already learned, what were his interests and what he could do; and 3. The opinions of his teachers and parents concerning his physical and mental capacities and the history of his physical and mental life. This order was followed in the conduct of my investigation, because I believed that the opinions of his parents and teachers should supplement but not bias the experimental investigation. In order to secure norms of comparison, two average boys from the sixth grade, and two boys of his own age were selected to be tested with him in certain of these experiments. The present report concerns itself with the mental condition which was revealed through the application of these methods of inquiry.

We shall first consider the condition of his sense organs, because their sensitivity determines the amount and character of the response which he could be expected to make to the stimulation of the external world.

Sensitivity of touch was measured by the two-point threshold upon the distal phalanx of the index finger of the left hand. The threshold was found to lie between 2 and 2.5 millimeters and evidenced normal sensitivity.

Each eye was tested separately for distinctness of vision. An oculist's chart was placed twenty feet from him, and he was asked to tell what he could see. Title pages of books printed in the same size of type used on the chart were also employed in like manner in order to make sure that his spelling of the chart was not due to some previous experience with one like it. He read one line more than can be read by the normal eye. A second test was made by hanging on a wall a white card on which had been

drawn two parallel vertical black lines, one centimeter long, and one millimeter apart. The subjects were required to approach the card very slowly, and to tell what they saw. Elmer saw two lines at a distance of eleven decimeters. The average distance at which the two boys of his age were able to see the two lines was, with small variation, nine decimeters. A single horizontal black line two centimeters long and about one quarter of a millimeter wide was drawn on a white card to test clearness of vision. Elmer approached within 6.5 meters of this card before he could see that the card had a line on it. The average distance for the other boys was 5.42 meters. These tests give evidence of slight hypermetropia in each eye. No test was made to find whether the retinae were in a healthy condition, but as no pain in the eyes was experienced after studying several hours on dark days, it is to be presumed that they were approximately normal. Judging from tests with the well-known figures consisting of concentric circles and of radiating lines, no astigmatism of any significant degree could be found in either eye. The boy sorted the Holmgren skeins in such a manner as to show no signs of color-blindness. He used water colors with sufficient accuracy to indicate that his judgment of color was excellent. The abnormality in Elmer's eyes was therefore too small to hinder perceptibly his acquisition of knowledge.

Elmer's threshold of least intensity of sound was found by the watch test to be 1.62 meters, and was practically equal in the two ears. This was three decimeters less than the average of the thresholds of the two boys of his age. Judgment of pitch was next tested. He thought that the two lower strings of a guitar were tuned at the same pitch, when they gave beats of five per second. As only one trial of this kind was made, the result had naturally little value. Simple German ballads, which he had never before heard, were sung to him, and after hearing them once, he could repeat them without an error. When some of these tunes were modified so as to make them less melodious, he reproduced them without hesitation. But when a tune which he had once heard was slightly altered, he objected. This gave sufficient evidence of fairly good judgment of pitch.

Tests in rhythm with auditory stimuli were made by means of a metronome. The instrument was placed on a piece of felt in a box, the lid of which was so padded that it could be opened and closed without noise. Elmer was seated with his back toward the box. The lid was raised to give accent to certain clicks of the

metronome. Thus the most usual accents in music, those of 2-4, 3-4, 4-4 and 6-8 time were given. But he insisted that the metronome merely said, "Click, click, click, click." His attention was then called to the accented beats in 4-4 time until he could indicate them. But this did not seem to aid him in discovering the accents in the other kinds of time. Elmer seemed, therefore, to be quite below the average in feeling for rhythm.

The examination of the higher stages of the knowledge-gaining process involved an investigation of imagination, memory, attention, and interest.

To determine Elmer's type of imagery, words and objects were used which were familiar to him in form and meaning. Several lists of twelve words each were prepared, and all the words of each list were read to him at a time, or he was permitted to read the words once on a brief exposure. He was then asked to reproduce all the words that he could remember. When these words were repeated orally, he was able to remember eight words having an auditory content, six words of visual content, two words of motor content but none without any sensuous imagery. When written words were exposed long enough to be read once, he remembered seven auditory, five visual and two motor words. Thirty small objects were exposed long enough for him to see each object once. He remembered only nine of them. In so far as a conclusion can be drawn from these few data, Elmer remembered auditory words better than visual words; words that he had heard, better than those he had seen; he remembered visual words better than visual objects.

That his memory was assisted very slightly by meaning, is shown in his remembering *broom* as *brook*, and *lamp* as *lamb*. The small part that meaning played in his memory processes was also evident in the fact that he committed a jargon of words with rhyme and rhythm as readily as he committed a stanza of equal length with meaning. The knowledge that Elmer acquired most easily was deficient in meaning. For example, he learned pure mathematics as readily as the average child; but he could do nothing with its applied form. He could not state reasons for steps in a process, but could follow reasons if not too difficult. He could learn only the most mechanical elements of English grammar, and could not write intelligently about the most familiar objects. He spelled poorly, as did other children in the School of Education, because spelling was taught there only by criticism of written work, and never by drill. However, he learned spelling with surprising

ease when taught in the usual way. He prepared four lessons each day in an eighth grade spelling book, and did this so well that frequently he did not miss a word for five days. Several stories of history, interesting to children, were read to him. The only parts of these stories that he could repeat were a few names. Two or three out of perhaps a dozen events in each story were recognized by him when the stories were told again. People were to him inexplicable, vacillating, inconsistent. He could not anticipate what a person would do under any set of controlling circumstances. The same was more or less true with respect to all physical objects except plants.

Through some unknown influence, he had for about a year shown an increasing interest in plants. He knew the uses of the various organs of plants. He had learned the names, the time of blooming and the conditions of growth of nearly all the plants commonly sold in green-houses, of many wild plants, and of forty or more of those in Washington Park. In nearly every window of his home were potted plants of various kinds which he had bought with his spending money. The yard about the house gave abundant evidence of the same interest. His ignorance of ordinary animals contrasted strangely with his knowledge of plants. Geography interested him only in so far as it referred to plants. Maps meant nothing to him; for he could not comprehend anything that he had not seen. The larger part of a list of questions regarding the sources, nature, and uses of about two hundred common objects drew forth such answers as, "I don't know," "Wool grows on the wool plant," "Pocket-knife blades are made of silver," "Butter is made of lard and soap," "I don't know." At first Elmer read blunderingly even the most simple reading matter. He hesitated over words that he could read rapidly when he was urged to hurry. He soon learned to pronounce words readily, but he could make his reading expressive only to a limited degree. He could get little meaning out of simple reading matter. Hence he could put little meaning into it. These observations and experiments point toward the conclusion that Elmer comprehended meaning with difficulty, and that therefore meaning could give him little assistance in memory or in any other process.

Untrained attention is a common cause of failure in school work. In the study of attention, the subjects crossed out the *a*'s in a page of printed matter. Elmer and six other children of fourteen years used the same prose selection. An effort was made in one portion of the experiment to keep the speed constant and

to allow the accuracy to vary, and in another portion to keep accuracy at a maximum and to allow the speed to vary. But this effort was unsuccessful. Elmer made one omission for every 16.5 *a*'s that he marked out, and the others made one omission for every 3.26 *a*'s marked out. Elmer crossed out 55.6 *a*'s per minute. The others crossed out, on an average, 14.2 *a*'s per minute. Elmer's attention gave much greater speed and accuracy than the average speed and accuracy of the others.

The capacity for self-expression was measured in terms of accuracy, rate, and force of movement, and in terms of fatigue. Accuracy of movement was tested in the following manner. A sheet of smooth white paper with ruled lines nine millimeters apart, was tacked on a thin board of the same size. A ruler was fastened over the paper so that its true edge was on one of the ruled lines. The board was placed on a table in such a way that the true edge of the ruler was toward the right and parallel with the arm used in writing. The subject was then told to begin each stroke with the pen on the paper and against the edge of the ruler, to move the pen to the right, and to stop it on the first ruled line. Two strokes were made per second. A rest of one minute was allowed after each one hundred and twenty strokes. The fingers and wrist functioned about equally in these movements. Each boy made six hundred strokes. The boys of Elmer's age succeeded in stopping on the line in 29 per cent of their strokes, the sixth grade boys in 17 per cent of their strokes, and Elmer in 26 per cent of his strokes. The board was then fastened to the wall at such a height that when a boy stood up to write, his elbow and shoulder functioned about equally in the movement. As these joints are accustomed to a wider range of movement, the strokes were to be stopped on the second line. The correct strokes were, for the older boys 18.1 per cent, and for the younger boys, 11 per cent, but for Elmer only 3.27 per cent of the total number of strokes.

Thus Elmer appeared to have very poor control over the larger, centrally located muscles, which are involved in this movement of the arm. The complex motor act of throwing at a target was undertaken as a further study of the control of the shoulder and arm muscles. Quantitative results could be obtained from the throwing of the other four boys, but none from that of Elmer, because he could seldom hit a target one meter by one meter in size, at a distance of four meters. Another indication of the relatively greater lack of control over the larger muscles than over the smaller

ones was found in his drawing. In some of his drawing lessons his arm was stationary on the table, and his fingers and wrist performed the movements. Other lessons were conducted in the parks with only a pencil and a drawing pad. In this case the elbow and shoulder played the principal parts in the movements. A great difference was evident in these two sets of drawings. His smooth, legible penmanship also showed, as do the facts recited above, that the wrist and fingers were under much better control than the elbows and shoulders. His work in manual training gave additional proof of the same difference. He could draw plans, and mark off his work as well as the other boys who were working near him. But he could not keep a back-saw within one-sixteenth of an inch from a line, or an ordinary saw within much greater limits. Around a nail that he had driven could always be seen a display of hammer marks, some of them as much as three inches from the nail. Weaving and paper-cutting, in which the fingers did most of the work, were tasks in which he excelled. In the gymnasium, where the shoulder muscles are the most used, practically every exercise that he undertook was a failure. Every evening and every Saturday the boys played ball on vacant lots near his home. But even when there were not enough boys for a team, Elmer was not allowed to play, because his slow, awkward, weak movements hindered more than they helped the game.

Power of movement, and fatigue, were tested by means of the dynamometer. His right hand registered twenty-eight kilograms, and his left hand twenty-four kilograms. The average readings for sixteen year boys in the Chicago schools are, for the right hand forty-four kilograms, and for the left hand thirty-seven kilograms. This indicates that Elmer was 35.8 per cent weaker than average boys of his age. When dynamometric records were taken every half minute, fatigue decreased his grip within the first ten minutes nearly three times as fast as it did for the other boys of his age. His readings also showed wide, spasmodic variations due to lack of motor control. In order to discover whether any of these motor phenomena were due to chorea, Elmer was told, during a geography lesson, to extend his right hand toward the east and his left hand toward the west, and to tell in which direction he was facing. There were no asymmetries in the positions of the arms and hands. Neither in this nor in his manner of lying down and rising were there any signs of chorea.

This investigation as a whole, inexact and fragmentary as it is in some parts, established, at least as probabilities, a strange

combination of psychological conditions. The normal factors, on the one hand, were found to be passive touch, clearness of vision, color vision, health of retina, acuteness of hearing, accuracy and rapidity of discrimination, interest in plant life, and memory. He could learn readily, reading, writing, spelling, drawing, water color painting, music, and pure mathematics. Slight differences from the majority of people were found in acuteness of vision, type of imagery, and control of hands. Astonishing deficiencies presented themselves in the control of the larger muscles, and the knowledge of the most common, every-day, immediate facts of life, including that knowledge of people which makes possible the study of such a subject as history. His teachers thought that he was becoming more stupid every day. But the facts seem to me to point in the opposite direction, for the development of the control of the large muscles and of knowledge of everyday matters, takes place chiefly in the first few years of a child's life. It was some time after this conclusion was reached that Elmer's father reluctantly revealed the story of the boy's life, of which the significant facts have been given in the first paragraph of this article.

During the first six years of life, he had seldom moved a muscle. This means that he did none of the lashing about that brings every healthy child into knowledge-yielding contact with objects. Although a temporary arrest of mental development during the common school period may entail only a temporary loss, this fragmentary study has shown, at least, that the dropping out of the first six years of mental development is a loss which, under ordinary conditions, may be largely irretrievable.