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SCIENCE AND THE RATIONAL ANIMAL¹

By Dr. MAX MASON

PRESIDENT OF THE ROCKEFELLER FOUNDATION

THE celebration of one's birthday, after a certain age, is probably sound psychoprophylaxis, but can hardly be met with unmixed feelings, even though "The Old Gray Mare" is not made the theme song of the occasion. One does not wish to be reminded of the passing of the milestones on a journey that is short and filled with interest and happiness. In early youth, however, the view is all to the future. At sunrise the mind and heart are absorbed with the joy of planning the day to come.

We are met to celebrate the fiftieth birthday of Sigma Xi, an institution which need never grow old and which now, on the time scale of the history of the race, is an infant drawing its first breath. Our interest

to-night is in its meaning for the future rather than in its brief past—its meaning as a symbol of the devotion of countless thousands and of countless millions to come to the life of science and to their faith in the scientific way of life. These are not mere phrases. There is a life of science in which we are united by fellowship in effort. There is a scientific way of living, and its attainment is the aim of all the sciences.

In accurate scientific knowledge there is power—power, as has been amply demonstrated, to release man from physical drudgery; power to release man from fear, that child of uncertainty, as he learns the story of the universality of natural law; power to determine his destiny as he understands himself to be a product of evolutionary processes and learns the psychological and physiological factors which condition his personality; power to give him peace and courage for life

¹ Address given on the occasion of the celebration of the fiftieth anniversary of the founding of the Sigma Xi, Cornell University, June 19, 1936.

in a friendly universe as he partakes of "the sweetness and glory of being a rational animal."

Whatever be the momentary problems of a troubled world, only the mistake of confusing the eddies in the rushing stream of human progress with the main current can lead to pessimism. It must be remembered that it is the sluggish stream which has no eddies. The Society of the Sigma Xi is only fifty years old, yet its life-period is one sixth of the whole time since the advent of the new learning. It is only three centuries since Galileo dared to find facts; dared to dispute the authority of Aristotle and to challenge the stifling power of organized superstition and mysticism. Man has been released from his fear of finding the truth regarding the behavior of physical forces. Only to-day is he overcoming his fear of finding the truth about himself, only to-day is he gaining faith in the applicability of the scientific spirit and method to the great problem, the problem of the distortions and difficulties that cripple the human intellect and the human spirit, retard the progress of the race in social organization and control, handicap man in his human contacts and in his individual performance, and violate the greatest of human rights, the right to be formed as a personality to the highest degree of intellectual and emotional power and stability which is consistent with his inherited organism. Through steady, patient accumulation of exact knowledge man has reached so far that he can at least perceive the course to be followed in his struggle for self-control. He has learned that control comes through understanding and that understanding derives from that patient and objective search for truth which is known as the scientific method. As he applies the method in daily life he promotes the rationality of life. As he derives and applies fundamental knowledge to the life processes, mental and physical, he gains power to control the growth and development of the individual and of the race.

Throughout the centuries man has pursued his quest for understanding and control. His efforts until the new learning were, except for short brilliant periods, crude and naïve. His strivings passed on a mixed heritage to the following generations. We can imagine the awe and wonder with which, before the dawn of history, he studied the stellar groups sweeping across the sky, and the glowing planets threading their way among the stars. The life-giving overflow of the Nile occurred with the appearance of certain constellations in the evening sky, and so may have arisen the belief that human lives are ruled from the heavens—a belief which promoted astronomical observations, but burdened man with a heavy load of superstition and mysticism. So eager was his desire for causes that a few coincidences determined unjustifiable beliefs which lived for centuries and renewed his store of superstitions.

The spirit of the new learning came into immediate conflict with the church. An organization based upon the belief that final truth had been revealed to man by supernatural means was compelled to resist the findings and aims of scientific searchers. The great religions had been so distorted from the simple teachings of their founders that many of the acts of their organizations and members were heartsickening examples of cruelty and inhumanity, although performed in the name of a religion dedicated to the idea of the brotherhood of man. There has never been and can not be any conflict between the aims of science and the spirit of religion, but the spirit of religion did not enter into the minds of those who lived for the passionate defense of the dogmas of a sterile theology. So man fought for emancipation from the chains of his own making, after the centuries during which he had remained bound to the Aristotelian milestones of his former progress. The familiar story is always new, always inspiring. As accurate knowledge was gained of the physical behavior of matter, the tools of mathematical analysis were developed and applied to gain simplicity of description and unifying concepts. In the lifetime of Sigma Xi the separate chapters of physics have become one, chemistry and physics have merged, and the knowledge and methods of beautiful accuracy and refinement in those fields have been brought to bear on the involved and difficult problems of the life processes.

Using the vast library of scientifically determined facts and concepts, the engineer and the inventor have revolutionized the mechanical surroundings of civilized life, speeding up to an almost incredible degree transportation, the interchange of intelligence and manufacture, but the resultant close coupling, within nations and between nations, of economic processes has greatly intensified the difficulty of economic stabilization. The changes have all tended to intensify the fluctuations of the economic system, a machine which shows the phenomenon of "hunting" produced by the inertia and time-lag of its governing mechanisms. The stresses on our social and political life which are thereby produced are ominously great, and solution waits upon the ability and willingness of man to learn and to apply control measures and to adopt a new business ethics based upon the mass implications of individual action in the present world.

It has become a commonplace to state that man's control over the physical forces of nature has outstripped his control of himself. Technology has given him intoxicating power, and some of the results are not surprising. I have no desire to attempt an estimation of those material changes in our lives which are usually termed progress, or to attempt a judgment of their effect on the well-being of man. Much must be entered on the wrong side of the ledger. The quiet

and peaceful valleys of the countrysides now echo to the roar of trucks. Flaunting signs, unsightly gas stations and dog wagons affront the eye; and that marvel of modern engineering, the radio, spreads throughout the land inanities which are listed under the title of humor, and exposes with pitiless fidelity the adolescent hysteria of political conventions, met to discuss the government of our country.

However significant may be the present and future rôle in civilized living played by the technological applications of physical science, this is far from the significant and basic meaning for man of the scientific method. His real problem is himself, and a new chapter in the life of man has been opened by the realization that three hundred years of scientific effort have taught him the method and brought together a vast collection of knowledge and of techniques for the study and control of human development and behavior, and arrived at a conception of man as a psychobiological organism governed by regular behavior patterns both physiological and psychological, which may be analyzed and controlled.

Such a thought would have been impossible a few centuries ago. Man was conceived as heaven-born, fixed, a thing apart from the rest of the organic world and not a product of evolutionary forces still in the making. It was impious to study even his dead body, that lowly and ignoble thing which only housed his mind and his soul.

The recognition of man with all his characteristics and behaviors as a psychobiological entity is one of many examples in which a deeper insight shows the essential unity of concepts previously considered as separate and even antagonistic. To the Greeks theory was celestial and noble, practice and experiment were terrestrial and ignoble. It took us many decades to see the unity between beauty and utility—to discredit art in a vacuum and to understand that concepts of beauty and grace are idealized from bases of efficiency. Scholarship removed itself from the life of reality. Business and philanthropy were put at opposite poles. Performance was divorced from education. Educational institutions introduced special personnel to be kind to students, relieving thereby the regular faculty from that obligation. The list is endless.

But to return to our theme. The irritability of the unicellular organism gives the response mechanism for self-preservation. In higher evolutionary forms a diffuse nervous system admits of more complicated reactions, and from it has evolved the central nervous system of the vertebrates. The brain is the organ of greatest change as we pass up the evolutionary scale, the spinal cord and sympathetic nervous system remaining much more constant. The higher the forms the more complicated are the possible reactions to external stimuli, the more adaptable the organism to

novel conditions. *Homo sapiens*, with his great power of association, rapidly became the dominating vertebrate. His responses to stimuli were determined by no mere set of reflexes. When met by a set of circumstances he could delay his response, and determine his action by the complex procedure we call "thinking things over." In imagination he could follow a series of possible courses of conduct and find the one to please him. He calls the result "logical," and the process "rational." He probably means that the associations and memories of past experience, both real and vicarious, awakened by the pseudo-experience of his accepted plan for conduct, call forth a greater glow of pleasure than those produced by other plans. As his civilization developed, "thinking things over" became an ever-increasing part of his activity, creating an enormous difference between his life and the life of even his nearest evolutionary relatives. But even if he lives an "intellectual life" man remains an animal. The neuro-physiological processes of his cerebral cortex remain geared to those of the thalamus, to the entire nervous system, to the endocrine glands and to his whole anatomy.

The marvelous powers of his complex organism have made him in truth the master of his physical environment. In his evolutionary progress he may have lost much, but so content is he with his extraordinary mental ability that he does not regret it. He has lost his fur and is afraid to sit in a draft, but he can make air-conditioned rooms. His children at birth are helpless, with almost no inherited action patterns, of any complexity, but they are the more capable of conditioning. He is peculiarly susceptible to infectious diseases, but he is confident of his ability to control and in the long run to eradicate them. Judged by his power over the physical circumstances common to all organic life, the highest evolutionary product is, by virtue of his highly developed central nervous system, a complete success. But this is not all the story. The use he makes of his nervous system has enormously changed in character as he has emerged from savagery—a time too short for the processes of evolution to follow. He has created a new manner of living and a new environment—a social environment—with whose problems he must wrestle. *Homo sapiens*, in his early days, hunted, fought and fled, much as his evolutionary forebears had done. He was a man of action, and the action was physical and immediate, though determined with insight and cunning. His emotions played the natural rôle of intensification of the physical effort adapted to the circumstances, stimulating the liberation of hormones, which in turn reacted on nervous system and muscles. To-day civilized man lives a mental life—thought and still more thought, that complex process of pseudo-experience, calling into action, both consciously and subconsciously, the countless associa-

tions formed throughout his life, with their emotional responses. The whole organism partakes of the process, but the primitive type of response to the call of neuropotentials and hormones does not occur. Anger is a valuable emotion for the savage, determining quick and forceful action, but it is a poison to objective and rational thinking. In modern life the hormone response to this and other emotions, and all the chemical changes which organize the body to meet an emergency do not find their normal primitive use. It is not surprising that the biochemical imbalances thus produced disturb the normal physiological behavior of the body and are responsible for much disease with definite pathology in modern life. The gastrointestinal disturbances were perhaps the first in which the psychogenetic factors were clearly recognized, but the list is an ever-growing one.

The disturbances of physical health which occur in the struggle of the complex and delicately balanced human organism to adjust itself to its self-made and continually changing environment are, however, of minor importance. We live for and prize the fruits of the human intellect and spirit. Disturbances of mental health strike at the very center of our existence, undermining individual happiness and effectiveness, social organization and control of our evolving civilization. Judged only by the cases of frank and disabling mental disorder, the casualties in the evolutionary struggles of man give a staggering total. As many hospital beds are used for mental disorder in the country as for physical illness. But even this is not the heart of the matter, and does not give the real picture, any more than the visible light from the sun gives the whole spectrum of its radiant energy. For every case of frank mental disorder there may be a score of borderline cases, a hundred lives of great unhappiness and low efficiency because of mental maladjustments, and millions heavily handicapped by distorted mental action patterns and emotional instability.

It seems clear that the gropings of man to understand the nature of the world and of himself lead to a recognition of his basic responsibility and problem. With his mind partially freed from the misconceptions and taboos of the past, he can view himself as a psychobiological unit in the organic world, with mental action patterns formed and conditioned by his experiences. To have arrived even as far as this is enormous progress. But we have gone much farther. Recent years have seen an ever-increasing application to the basic problem of human life, of all the methods, detailed techniques and vast stores of the exact knowledge of science. Man's greatest intellectual achievements are being focussed to resolve man's greatest difficulties. The vital problem is being attacked by the great method. We could not ask for more.

I should like to look at the human behavior problem by using an analogy. Analogies are dangerous, but offer a tempting refuge for one whose interest and enthusiasm for the work of this field is not hampered by the possession of exact knowledge in it, and who can not forget the words of Alice in Wonderland—"I could explain this better, if I understood it myself."

Suppose a great number of automobiles were given to a completely isolated group of people, who had no knowledge whatsoever of an automobile and a rudimentary knowledge only of simple mechanical actions. They would surely be agog at the occurrence, and would waste no time in getting at the mystery of their operation, each according to his way of problem-solving. Many would begin to push and pull everything in sight, the more intelligent proceeding according to system and keeping record of their experiences. Another group would certainly begin to take their automobiles apart, their investigation following a logical course as they traced the connections of wheel to differential, to shaft, transmission, clutch and engine. A member of the first group, Mr. A, seeks generalizations which may lead to understanding enough to drive the car. A member of the other group, Mr. X, seeks detailed understanding of the whole mechanism. Undoubtedly A will first drive a car—he would beat X by years, and perhaps decades. Before long, pressure on the starter will start the engine—and from that point progress will be rapid, until the car can be used. Mr. X will be more of the temper of the pure scientist. He will insist that the only way to proceed is to gain detailed knowledge of every part. He will not think too highly of the progress of A, even when he exultingly drives past him, and he will not relish A's irritation at the slow progress of his microscopic methods. But before long, cooperation will become inevitable, for A will have trouble. X may have a poor picture of the operation of the car as a whole and no skill in driving, but he may know much about clutches and understand why they slip, and his fellow specialist, Y, may be just the man for ignition systems. The two methods of study are sensible and desirable. The more immediate results are gained from the more superficial general study. The combination of the two procedures gives adequate comprehension in the long run. Neither method is more "scientific" than the other.

One group of workers in the field of human behavior is searching for the major action patterns of the mind—for generalized coordinates. It is again in the lifetime of Sigma Xi that they have made great progress. Their search for correlations has uncovered the rôle of the subconscious in determining mental action and has given insight into the origins of those disturbing complexes which are so strong that they warp mental reactions over a vast range of associations. Study

of the character and origins of disturbed mental behavior is giving insight into the normal, and into the determination of personality traits by the emotional experiences in the early years of infancy. Compelling and startling force is given to the thought of the responsibility of each generation for the well-being of the next. The concept of the average human as a rational being emerges considerably battered, as we understand something of the subconscious emotional carry-over of past experience. We shall have to admit that each individual has at best a conditioned rationality. But this is real and great progress, for it compels an objective attitude of man to himself, a search within himself for the existence and causes of his own prejudices, a sympathy and understanding for the prejudices of others and a deeper meaning to the responsibility of parent and teacher.

It is natural that the students of behavior, psychologists and psychiatrists, have their competitive and sometimes antagonistic groups and schools. The field is one of perplexing difficulty, the work is young. But valuable knowledge is always ultimately accepted, even when obtained by a school whose adherents antagonize others by the exaggeration of their claims and the narrowness of their methods. In a scientific theory, an analogy is set up between the end results of the interaction of stated entities obeying stated laws, with the results of observation. "Reality" of the entities, physical or psychic (whatever that means), is of no great moment. The analogy constitutes the theory, which is "true" or useful to the extent that it describes and correlates phenomena. Some of such theories may be of great value, even though they are manifestly very incomplete, and will probably be of short life. This is undoubtedly true of many of those now prevalent in both psychiatry and psychology.

In addition to the work of the psychologist and psychiatrist, that of the cultural anthropologist has been of great value, and has thrown light on the older narrow and naïve conceptions of the intrinsic patterns of human behavior—of so-called "human nature."

Thus are Mr. A and his colleagues seeking for new knowledge and applying the present store to the difficult problems of psychotherapy and mental hygiene. Their insights are illuminating to the field of education and to general medicine. The interplay with the latter is very close. Many disorders have been moved from the heading "somatic" into "psychic," and *vice versa*. More fall under both headings. The distinction between "organic" and "functional" disease is losing its meaning; as more refined techniques of observation and study become available. The pendulum swings between the side of the psychological and the side of the somatic as new understandings occur, but cooperation between these instead of contest is now the word.

Our analogy with the A's and X's, like all analogies,

breaks down very easily. There is a continuous gradation between these extremes. Over a score of separate scientific fields are represented in the behavior problem, each with an army of workers. New biophysical and biochemical insights are brought to the aid of the neurophysiologist. Mathematical treatment of neurophysiological action and of cell behavior is making its modest beginnings, dealing first of necessity with highly simplified systems. The complicated rôle of the hormones and the interplay with the nervous system in health and in disease are being slowly unraveled. The difficulty is great, and makes impossible demands of the organic chemists, who are struggling ably to meet them. The advances in the whole field of the life sciences remind one of those in physics at the turn of the century. But however fast they are coming, so sharply are they focusing on the problems of most crucial importance for man that the layman hopes for even greater speed, his imagination fired by the vistas that are continually opening for further gains. The boundaries between some of the disciplines are being broken down, and at last men are training themselves for work at problems rather than for membership in departments, while cooperation between specialists of different fields is constantly increasing. The problems demand and should have the full support of the basic sciences, not merely their tools—for the viewpoint and type of curiosity of a physicist are as important in a problem on neural action or cortical potentials as the oscillograph to be used.

Only a few of the possible optical, electrooptic and magnetooptic effects have ever been used in the microanalysis of body fluids, hormones and vitamins—to mention but one small subfield.

To pass in review the growth in knowledge and power of the life sciences, during the last few decades, is an inspiring experience. The conviction is gained that we have in them truly the beginnings of a science of man. The previous three hundred years have served the purpose of establishing methods and preparing tools and techniques. A new chapter in the history of science and of man is beginning as all the sciences are brought into coordinated attack on the vital problems of his future.

Our civilization can advance as the art of living is enriched by the application of knowledge won through the sciences. But scientific and technical knowledge may be used to retard and even to destroy the things most valuable in our lives, if their use be distorted by prejudice, passion or individual and group selfishness. The safeguard is to be found in proper emotional education, both formal and informal, for the attainment of self-control and the acquirement of the objective attitude. These qualities are the essence of the scientific attitude, and are characteristic of the scientific worker when he is in his laboratory.

Those sciences advanced most rapidly for which the objective approach was most easy—in the fields remote from personal prejudice. The success of the method made its application possible in fields lying closer and closer to those in which man's rationality was more highly conditioned. Each success should give increased impetus to the process of the rationalization of life—to the application of the objective attitude and scientific approach in all the affairs of living. An especial responsibility for the furtherance of this process surely lies with the scientists who should so thoroughly appreciate its value.

To-day wide publicity is given to new scientific discoveries and theories. There is no lack of public interest in the results of scientific research. I wish there were a corresponding desire to utilize to the full the simple lesson for life that the success of the scientific method teaches and a compelling belief that the world could be made a different place if this were done.

The Society of the Sigma Xi is a brotherhood of those living the life of science. Let us imagine a new organization—a brotherhood, let us say Alpha Omega—dedicated to the scientific way of living. The possession of special scientific techniques is not necessary for membership in Alpha Omega. Its members believe in finding facts, they know of the stores of accurate knowledge that have been collected by the objective search for truth in all fields of human interest. Some of them they can use themselves—for others they must rely on their fraternity brothers who have special knowledge. The password of Alpha Omega is the question, "How do you know it?" followed by the question, "What of it?"

The Alpha Omegas are not universally popular, for they take an aggressive attitude to some of the foibles of their friends. They do this because they believe that little things add together to make large things, and that mental attitudes are contagious. They continually see small and apparently harmless examples of belief and action that remind them of the burning of witches, of lynchings, of cruel intolerance, of the KKK, of the Black Legion, of mass murder in the name of patriotism. And so they do not keep their passwords secret—they use them every day. They have many lighter moments that serve to keep them in practice. An Alpha Omega who plays bridge has many opportunities for this, and since one thing leads to another, may even gain a convert or two. His

partners give up sitting on their handkerchiefs to change their luck. They know the difference between the statements that "the cards are running north and south" from "the cards have been running north and south." They learn to derive as much pleasure from exhibiting indifference as to which deck they play with as they used to gain in winning the cut and choosing the "lucky" deck. Fewer of his acquaintances believe that they are "poor holders" of cards, or that they always have been, and are to be, in general, unlucky, but this progress was probably gained at a cost and only after some discourteous remarks on mental attitudes to life. After some time the friends of our Alpha Omega begin to see some system in his peculiar conduct in what they judge to be small matters, and if so the heaven is working. They no longer recite as a fact the tale of a man's hair turning white over night, but instead have learned something regarding credulity and a bit of physiology. The universal belief in the old-fashioned winter has been replaced by an appreciation of the reasons for such beliefs and perhaps a little interest in climatology. The family legend of Uncle George, then a thousand miles away, appearing to Aunt Susie is no longer heard. Perhaps an interest in the ability to describe an occurrence as it actually happened and to repeat this many times with fidelity is gaining ground, and may make some headway against the interest in dramatizing an account. While our Alpha Omega hopes to keep his own emotional reactions under control, he lets himself go when he meets the vicious cruelty of the male or female gossip. "How do you know it?" and "Well, how does *he* know it?" is a simple and effective weapon for decency and sanity. Unless there be shown some respect for the characters of our political leaders, we can hardly expect their ranks to be recruited from decent men. Our Alpha Omega has a hard time during a political campaign.

We can not be true to the spirit of science in our laboratories and false to it in our lives. We can not have faith in the rationalization of life without seeking to promote it. In that effort we must not overlook the obvious because it is so simple. We can not follow the example of the common council, which, by motion, resolved: "That the Fourth Ward Marsh be, and it hereby is, drained."

Members of Sigma Xi and friends, I invite you to membership in the Society of Alpha Omega.

OBITUARY

FRANKLIN DAVIS BARKER

In the death of Professor Franklin Davis Barker, chairman of the department of zoology of Northwest-

ern University, on July 10, at the age of fifty-eight years, the profession of zoology and more especially the field of parasitology have sustained a loss. Pro-