SOME UNSOLVED PROBLEMS OF THE SCIENTIFIC CAREER

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PART I

Introduction

IT IS my thesis that the life of a young scientist challenges our educational system from top to bottom with a series of unsolved problems which await investigation. Among these are certain subtle problems, arising out of unrecognized neurotic forces, which are basically important both in the choice and in the pursuit of scientific research as a career. This will constitute Part I of this paper. Part II will consist largely of a discussion of socio-economic dilemmas which also influence the scientist's emotional and intellectual career. It will not be the purpose of this paper to argue that every young scientist should be psychoanalyzed; and the reader is asked to keep this disclaimer in mind. Nevertheless in any multidisciplinary investigation of these complex interrelated problems, I believe that the psychoanalytic study of a random sampling of scientists, both young and old, would be one of the essential instruments.

In this connection it will be argued that Science in the abstract and Scientists as human beings pay a high price for the fact that during the preparation of young people for a life of scientific research their emotional problems are generally overlooked. This discussion will not attempt to outline a full remedy for this neglect, for it would be premature to make such an attempt before more is known about the problem. Here again, however, in exploring possible remedies, a psychoanalytic study of an adequate sample of young scientists would provide information which would help towards an ultimate solution. I hope that this paper will also contribute to a more general recognition of the fact that many young scientists require special help in their struggles for emotional maturation.

My own clinical experiences with this group suggest that the emotional problems which arise early in the careers of young scientists are more taxing than are those which occur in other careers. Yet without instruments with which to measure and compare these imponderables, this cannot be proved. Nor can it be claimed that the problems to be detailed below are peculiar either to science in general or to any special field of science. In fact, since the stresses which arise in different careers have never been systematically compared, it cannot even be determined whether or to what extent emotional problems vary from one career to another, either in degree or kind. Therefore, the reader may well ask why this paper is published before such investigations have been car-

ried out. Its justification lies in the fact that such studies will themselves require a large investment of time, money, and trained personnel, none of which will be made available until responsible educators become convinced that such studies are essential enough to justify careful planning, a coordinated multidisciplinary approach, and generous financial support. Before such studies are made, all that we can do is to indicate fragmentary observations, which suggest that it would be enlightening to make socio-economic studies of the lives of young and old scientists, plus psychoanalytic studies of a statistically adequate random sample of them.

These investigations would throw light on such problems as: (*a*) the special stresses, both economic and psychological, which occur in the life of the young scientist; (*b*) the great variety of conscious and unconscious forces whose interplay determines a young man's choice of scientific research as a career; (*c*) the interplay of conscious and unconscious forces in his subsequent emotional and scientific maturation; (*d*) how the special stresses which develop later in life react upon the earlier emotional forces which originally turned him towards science; (*e*) how unconscious stresses influence the young investigator's general approach to scientific research and scientific controversy; (*f*) how the unconscious symbolic significance of particular scientific problems and theories can distort the logic and the judgment even of men of exceptional ability. This article will attempt only to illustrate the wide variety of problems which are relevant to these general headings.

As a personal note I should add that my observations, both on myself and on colleagues in various fields of science, have been made at random over a period of nearly thirty years. They began in the Twenties, when I was working in one of the laboratories of the Rockefeller Institute. It became known that I had had some previous training in psychiatry. Presently I found that if I were to have any time for my own work I had literally to lock my door for a few hours each day. Otherwise, almost every afternoon, young colleagues and sometimes older ones would drift in to talk, not about scientific issues but about their personal problems. At that time my psychiatric training and experience were limited, and I knew nothing at all about psychoanalysis. Yet these random and unsolicited revelations made it clear not only that, as one would expect, a scientist's ability to endure the prolonged frustration and uncertainties of scientific research depend on neurotic components in his personality (both masked and overt), but also that there are significant relationships between masked neurotic components in the personality of an apparently normal scientist, and such things as (*a*) the field of work which he chooses; (*b*) the problems within that field which he chooses to investigate; (*c*) the clarity with which he habitually uses his native capacity for logical thinking; (*d*) the ways in which he attacks scientific problems;

(*e*) the scientific causes which he espouses; (*f*) the controversies in which he becomes entangled and how he fights; and (*g*) the joy or sorrow which is derived from the work itself and also from his ultimate success or failure. Thus over the intervening years I have seen men of imagination and erudition whose scientific lives were nonetheless baffled and unproductive, and also men with lesser gifts who seemed to function freely, creatively, and productively; scientists who were happy in spite of failure, and others who became depressed in spite of acknowledged and recognized success. Although such facts were new to me twenty-five years ago, they had long been an accepted part of human wisdom. This makes it strange that their deeper sources in human nature and their special importance to scientific workers have never been systematically explored. I cannot attempt such an exploration here, but it may be possible to make articulate the challenge to all scientists which lurks in these ancient and unexplored caverns of the human spirit.

The Emotional Equipment Which the Young Scientist Brings to His Career

The young scientist often reaches maturity after a lopsided early development. In this development he resembles many other intellectuals. A typical history is that an intellectually gifted child develops neurotic tendencies which hamper his early aggressive and psychosexual development. If at this point he is intellectually stimulated by one or another of the emotionally significant adults of his life, he is likely to turn away from athletics and the social life which he finds difficult to more bookish activities, thus postponing indefinitely any facing of earthier challenges. If success rewards his consolatory scholarly efforts during adolescence, he may in later years tend to cultivate intellectual activity exclusively. In this way absorption in the intellectual life will frequently be paralleled by an increasing withdrawal from athletic and social and psychosexual activities. As a result, by the time adult life is reached his only triumphs and gratifications will have been won in the intellectual field, his range of skills will have become restricted, and the life of the mind will be almost the only outlet available. Because of the extra drain of the laboratory on the student's time, the young man who sets out to become a scientist spends his adolescence putting every emotional egg in the intellectual basket to a greater extent than is true for most other young intellectuals. By such steps as these, the sense of security and the self-esteem of the young intellectual come to stand on one leg; so that when research is begun he invests in it a lifetime of pent-up cravings. After such a development, it is inevitable that scientific research will be supercharged with many irrelevant and unfulfilled emotional needs; so that the lifework of the young scientist tends to express both the conscious levels of his intellectual aspirations and his unfulfilled instinctual needs and unconscious conflicts.

Even the most brilliant scientific successes cannot solve unconscious personal problems, nor gratify unrecognized instinctual pressures. Whenever anyone works under the whiplash of unsolved unconscious conflicts, whether he is painting a picture, writing a play, pursuing a scientific discovery, or making a million dollars, the individual is prone to work with desperation. If there is failure, he blames unhappiness on his failure. But, to his amazement and dismay, he discovers that depression may follow success no less than failure. Basically this is because success also leaves his deeper problems unsolved. If we always bear in mind that the pursuit of unconscious and often unattainable needs plays a determining role in the intellectual career, the familiar phenomena of depression attending success would not perplex us. We should wonder rather at the shortsightedness of a process of scientific education in which self-knowledge is the forgotten man, and in which emotional maturation is left to chance.

The Choice of a Career

The aspects of this vexing problem which are peculiar to a career in science require certain general considerations. I suppose that it is not inaccurate to say that of the many unsolved problems of human life two which are of major importance are how to enable successive generations to learn from the mistakes of their predecessors without repeating them, and how to make it possible for young people to anticipate the future realistically. Not literature nor the arts or formal education has solved these two problems, which are interdependent in every aspect of life. Both are relevant to the choice of a career. When a youth decides to become a doctor, a lawyer, a businessman, or an artist, the decision is not made on the basis of a realistic foreknowledge of what one of these careers would be like as compared to another, nor out of a deep introspective knowledge of himself and of how he would fit into the lifework he has chosen. Even if his own father is a lawyer or a doctor, he will have had an opportunity to observe only the outer aspects of that life, the dramatization of its activities; he cannot have felt its joys and sorrows directly. What he will have experienced vicariously through identification with his parent will depend less upon what that life was really like than upon how it affected him; and upon the subtle balance of conscious and unconscious, hostile and loving components in his identification with the parental figure. Nor do adults know how to communicate the truth about their own adult lives to their children. Consequently the adolescent's and even the college student's anticipation of the quality of life in any future career is dominated by fantasies. To a remarkable degree this is true even of more familiar and humdrum careers. The quality of adult living belongs to the remote and mysterious future; it is something the flavor of which the child cannot anticipate. Until this obstacle to

communication between the generations is overcome, successive generations will continue in the future, as in the past, to make their choice in the darkness of fantasy and confusion. The child of a wealthy broker who was "on the street" took these words literally, as children do, and looked for his father in every pushcart peddler who passed. Although the visual misconception of the child was corrected as he matured, an emotional hangover remained which had an important influence in determining the choice of his subsequent lifework. Usually the less familiar the career which a young man chooses, the greater will be the importance of fantasies, both conscious and unconscious, among the forces which determine the initial choice of a career, and also the subsequent adjustment, happiness, and effectiveness in the one selected.

One natural conclusion to be drawn from these considerations would seem to constitute an argument for the wider use of aptitude testing in the choice of careers. Actual experience, however, and a hard-headed and realistic skepticism make one cautious about expecting too much help from these devices. The most extensive trials of the value of aptitude testing were the so-called "Stanines," which the USAAF developed during the war for the screening of air cadets and their allocation to training as pilots, bombardiers, and navigators. In terms of its relevance to this problem, I would summarize the results of this experience as follows:

(*a*) The tests of aptitudes were remarkably accurate as far as they went.

(*b*) It was possible to sort out those with the automatic speed and motor skills and/or the mathematical precision needed for various tasks.

(*c*) Men were placed accurately on a point scale as to their relevant psychometric and neuromuscular capacities.

(*d*) In this way the tests selected accurately a small group at one extreme most of whom would succeed in training, and another small group at the opposite pole most of whom would fail. (There were exceptions to the results even at both extremes.)

(*e*) As was to be expected, however, the vast majority of the men tested fell into the central zone of the normal curve of distribution, while only a relatively small percentage of the tested population was placed at the two extremes.

(*f*) With rare exceptions, the individuals who fell into the extremes knew their own aptitudes and ineptitudes before going through any tests. From their experiences at play, in sports, in school, and on various jobs, they knew already that they were specially adept or specially maladroit with respect to certain types of activity. Indeed the representatives of the two extreme ends of the scale were usually able to describe their strong and weak points almost as precisely as these could be measured.

(*g*) Consequently the tests are of greatest use when jobs are scarce in

times of peace, or else in times of war when a lad may want desperately to be accepted by a special branch of the service for some particular position, and may therefore exaggerate his native skill or hide his native ineptitude. But at other times when there is no special incentive to deception (beyond the usual need for self-deception), the men at the end zones need no tests.

(*h*) The next important lesson of the entire experiment with the "Stanines" was that for the majority, who fall in the great middle zone of the normal curve of distribution, although their minor variations in aptitudes can be measured with considerable precision by various "human engineering" devices, these variations do not determine either success or failure, happiness or unhappiness in a career. By exclusion, therefore, we may conclude from the results of the "Stanines," that for most of us (that is, for the Average Man) a subtle balance of conscious and unconscious forces determines how effectively we use our native aptitudes, whether intellectual, emotional, sensory, neuromuscular, or any combination of these aptitudes. For most of us it is not the minor quantitative differences in the machine itself, but the influence of these conscious and unconscious emotional forces on our use of the human machine which determines our effectiveness. For me this was the ultimate lesson from the experience of the Air Force with the "Stanines," and I believe, furthermore, that this result is what might be expected in any similar effort to predict success and failure in civilian careers by the use of precise aptitude tests alone.

This is the stumbling block against which the aptitude testers always stub their toes and until they learn how to evaluate with equal precision the influence of unconscious emotional forces, they will continue to mislead young people into thinking that scores on aptitude scales will determine successes and failures, happiness and unhappiness in their lifework.[1]

Although these unconscious, irrational, and symbolic forces are subtle and difficult to describe, they determine how most of us use our equipment, and the fate of our lives under conditions of success as well as failure. We shall attempt to discuss a few of these forces in relation to scientific problems and also to the life of science. To youngsters, the dream of a life of scientific research is charged with complicated and usually unnoticed symbolic connotations, which alter steadily during growth from youth to manhood. Therefore, what science "means" consciously to any mature scientist has as many unconscious layers as the stages of

[1] As a sharp contrast to the engineering approach of the aptitude testers, I would cite the studies which Anne Roe has been making since 1946. She has used various projective techniques, certain aptitude and psychometric devices, personal documents, life histories, and personal interviews to study the personalities of various kinds of scientists, scholars, and artists [5]. Her results are necessarily still fragmentary but already they offer many suggestive leads, and her bibliographies are essential guides to the scanty literature in this field. The results also indicate how enormous is the amount of work which remains to be done.

his interest in science. No valid generalizations can be made about this condition until many scientists have been studied analytically and the data collated.

Some of those who show scientific interest and capacity in their youth subsequently lose these qualities completely, whereas others pursue them throughout life. In only a few instances has it been possible to study the evolving symbolic connotations of a scientist's interest in scientific matters. In these few cases the "scientific" interests of early childhood frequently turn out to have been in part a window-dressing for quite different concerns. I cannot overemphasize the importance of keeping the fact in mind that human behavior is like a centipede, standing on many legs. Nothing that we do has a single determinant, whether conscious, preconscious, or unconscious. In singling out certain neglected unconscious symbolic determinants it may often sound as though I were overlooking all of the others. This is only because I want to emphasize the importance of the unconscious forces, precisely because they have been neglected so consistently, and because, as a direct consequence of this neglect, they tend to be destructive.

One of these unconscious forces is the child's fearful and guilt-laden curiosity about the human body, both its tabooed external aspects and its mysterious inner workings. A familiar example of this force may be noted in the physician whose interest in medicine has some of its roots in the child's buried envy of the doctor who could gratify the forbidden bodily curiosities and enter the sickroom from which the child was excluded. How universal this drive would be, and how it would vary with the age of the child and the quality of his relationships to others cannot be decided by guessing. Nor can I document this forcefully without presenting a mass of clinical data for which there is neither time nor space. Somewhat scattered data, gathered during the occasional opportunities to make analytical studies of various kinds of scientists, have shown that even widely varying forms of scientific interest can serve as an acceptable cover for some of the forbidden concerns of childhood. Furthermore, this tendency to utilize various facets of the outer world as a symbolic projection of inner conflicts does not cease when the child becomes adult, but may continue throughout life. This fact is of more than academic interest, since the scientific activities of the adult can be distorted by the same unconscious childhood conflicts out of which his original interest in science may have arisen. Indeed this must result whenever adult activities continue to represent earlier conflicts, and projections of unconscious personal conflicts can often be recognized even through their adult scientific disguises in the reasoning and experiments of outstanding scientists.

As an example of the role of unconscious residues of childhood's battles, I would cite the gynecologist whose ancient and infantile

curiosities were not to be satisfied by the justified activities of his profession, and who was plagued by an insatiable compulsion to visit burlesque shows. One could hardly ask for a better experimental demonstration of the fact that unconscious needs cannot be gratified by conscious fulfillment. A comparable example is found in the X-ray man whose choice of career was determined predominantly by his unconscious curiosity about the internal structure of his mother's body. In all innocence both men dedicated their lives to the service of childhood cravings which were buried in guilt and fear. It should be our goal to learn how to guide gifted young men so that they will not build their entire lives on such psychological quicksands.

Neurotic Distortions of Scientific Research: General Considerations

The first step in any program of scientific research is to observe natural phenomena while taking care not to alter these phenomena by the very process of observing them. In spite of the most meticulous care, however, the ever-present unconscious forces of the observer color in some degree the glasses through which he makes even simple observations. Therefore it is out of such tinted observations that he develops his scientific theories. Initially, these are hypotheses about possible relationships between the observed data. Hypotheses are always more vulnerable to distortion by unconscious processes than are the primary observations themselves. Therefore the next step for the research worker is to test his theories, together with their inevitable distortions, in experiments which either isolate and quantify the original data, or that test the consequences of the derived theories. Without our realizing that this is occurring, the process of investigation tends in this way to balance the distortions introduced by unconscious bias. Once he has set up his initial experiments, however, the scientist again becomes an observer. Now, however, he no longer observes facts in nature, but rather in a milieu which he has created artificially by means of his experiment.

Each successive step in these scientific processes calls forth a greater investment of conscious and unconscious feeling; yet if the experimenter is to be objective about the outcome of his experiments he must somehow manage to climb out of his own psychic skin so as to be able to criticize his own handiwork. This is as essential to objective scientific work as it is to artistic creativeness, but it is never easy, because it is impossible for an investigator to prevent the intrusion of his unconscious biases into such sequences of experiment and observation.

Furthermore, even these steps constitute merely the foundation for another round of observation, theory, and experiment. From experimentally derived observations come a second order of theories, in which unconscious biases have even greater weight; and these theories in turn

must be subjected to new experimental tests, which require still further sequences of observation and of theory. Thus the structure of science adds layer on layer, each burdened by more subtle and complex unconscious emotional investments, demanding of the scientist an ever greater clarity about the role of his own unconscious processes in his conscious theories and experiments, and each requiring an ever more rigorous correction for the influence of unconscious preconceptions.

For none of this self-critique in depth does our educational process prepare us. Yet much of it was implicit in Claude Bernard's *An Introduction to the Study of Experimental Medicine* [1] when he wrote: "The metaphysician, the scholastic, and the experimenter all work with an *a priori* idea. The difference is that the scholastic imposes his idea as an absolute truth which he has found, and from which he then deduces consequences, by logic alone. The more modest experimenter, on the other hand, states an idea as a question, as an interpretative and more or less probable anticipation of nature, from which he logically deduces consequences which, moment by moment, he confronts with reality by means of experiment."[2] Again in another connection Claude Bernard pointed out that the scientist and the philosopher are subject to the same internal human laws, prey to the same emotions, prejudices, and biases, and that these operate equally in the philosopher and the scientist. The difference is that for the scientist the fact that a theory seems true to him, that it feels true, or even that it is logically or mathematically possible does not make it true. For the scientist, the theory is not true until he has taken it to the laboratory, "leaving his theories in the cloakroom," and subjected it to the ultimate test of the experimental method [6].

Other observers of the world of science have referred to this fact. Every scientist can read with profit and delight Charles Richet's spirited and witty *"Natural History of a Savant"* [7], and Gregg's sage volume of lectures on *"The Furtherance of Medical Research"* [2], both of which touch on these questions. More recently R. C. Tolman [9] referred challengingly to "the criteria for selecting diligent and competent scientists, the effects of personal bias on results, the relation between subjective origins and objective outcomes of scientific experiments."[3]

This is a portrait of the ideal scientist, ideally in action. It implies that the subtle interplay of reason and emotion, and of conscious and unconscious forces, are as important in the lives and activities of scientists as

[2] Bernard, *op. cit.*, pp. 27–28.

[3] In the same paper (p. 4) Dr. Tolman makes a further series of comments which are directly relevant to our problem . . . "he (the scientist) selects this program . . . not to obtain results . . . but to satisfy his own subjective needs, . . ." . . . "The origin of problems is a subjective one, . . ." . . . "On the basis of many such nightly reflections, that which has objective validity is finally abstracted out from the welter of subjective experience in which scientists as well as other human beings are immersed. . . ."

of anyone else. If this is true then nothing could be more important to science than that scientists should know themselves in the neo-Socratic or Freudian sense, that is, in terms of the interplay between their own conscious and unconscious processes. Yet, as we have already stated [4] in the education of the scientist, as of everyone else, self-knowledge in depth is the forgotten man of our entire educational system (*Cf.* Lombard, [5]).

Since the father of modern physiology, a great immunologist, a senior statesman among medical educators, and a great atomic physicist all have recognized the confusing influence of subtle psychological processes in scientific work, then surely it is time for the problem to be made the central focus of a major investigation, in which psychoanalytic techniques will be one of the essential tools.

The Distortion of the Creative Drive by Neurotic Forces

It is rarely recognized that research makes demands upon the young investigator which may exploit his neurotic vulnerabilities. For instance, a drive for "originality" may cloak a difficulty in mastering existing facts and techniques, or it may serve to disguise an unconscious hostility to all existing authority. How often is this drive for originality naively mistaken by teacher and student for creative scientific imagination? How often, therefore, is the young investigator encouraged to penetrate into new territory before he has mastered the terrain from which the expedition must start? It is no answer to these questions to say that the same misinterpretations occur among young artists, writers, and musicians. Fallacious values and goals are destructive whenever they occur and in many different fields of work. Nor does it lessen the significance of any of the examples which follow to dismiss them as psychopathological. Such pathology is only an exaggeration of what occurs in more subtle and disguised forms in everyone. The wider and more easily recognized deviations of pathology illuminate the "normal" for us, and sensitize us to slighter anomalies which we otherwise would overlook.

For instance, unresolved neurotic anxieties may impel one overanxious young investigator to choose a problem that will take a lifetime or, alternatively, may drive another into easy, get-rich-quick tasks, which yield a yearly paper, a yearly acclaim, the yearly promotion. The former tendency to postpone the day of reckoning indefinitely occurs in the young scientist who deals with his anxieties by pretending that they do not exist. The latter is found in the man who finds it impossible to endure suspense and uncertainty for more than a few months. Neurotic anxiety can take either form; and young scientists frequently walk a tightrope between these two alternatives, that is, between the annual piecework type of productivity and the long-drawn-out tasks which post-

pone indefinitely any ultimate testing of theories against experimental data and observations of nature.

Then there is the battle with phobic indecision over which task to undertake, or how to undertake it: an indecision which may arise not out of an inadequate mastery of specific facts and techniques, but from a general neurotic tendency to obsessional doubting. I have seen this symptom work identical destruction in the careers of a young playwright who could not decide which of two equally good plots to use, and of a young chemist who could not decide which of two equally promising leads to follow.

There was also the scientist who had proved his case, but who was so driven by his anxieties that he had to bolster an already proved theorem by falsifying some quite unnecessary additional statistical data. This was a compulsive act, comparable to a kleptomania by a wealthy man, or to the action of a successful and famous writer who suffered from a compulsion to insert a few words from someone else into everything he wrote.

Again there is the scientist who is always pursuing a new scientific father. This occurs more frequently than is realized. One outstandingly able young scientist ran through five careers, abandoning each one after a brilliant start just as he reached the point of launching his own independent work. When he could no longer postpone accepting a professorship, he broke down and disappeared from the world of science.

But the most ubiquitous tragedy of all is the anxiety-driven scientist who lives on a treadmill—the man who has tasted what it means to gain temporary easement from his anxieties by doing a fine piece of scientific work, but who thereafter is driven not by a quest for further truth but by an insatiable need to repeat the same achievement in an effort to assuage anxieties whose origins were unconscious. This investigator uses scientific research precisely as the man with a handwashing compulsion uses soap and water, or as an addict uses drugs.

I cannot leave this phase of the problem without referring to one highly technical and complex issue. In psychiatry we recognize certain rough parallelisms between types of illness and types of personality. These can have comparable influence in research. During the exploratory phase, while crude data are being gathered, an investigator ought to be free from rigidity. He should be ready to abandon preconceived objectives and anticipated goals, so that any hints that come from unexpected findings can be pursued. He must be psychologically free to follow uncharted courses. Therefore, premature systematization of the data must be avoided. This requires that type of free and imaginative flexibility which is sometimes attributed to the so-called "hysterical" personality. Later, a more rigid process is required, one which has some of the features of the obsessional neurosis, or even some of the tendency of a paranoid patient to organize his delusions into logical systems. Scientific

research thus seems to require that, as the work progresses, the investigator should be free to operate now with one type of personality and now with another. It would be profitable to compare analytically the personalities of those scientists who can change in this way and of those who cannot, especially in relation to their scientific productivity. This would seem to be a problem of basic importance for the optimal use of scientific personnel.

Dr. Anne Roe has given me permission to quote a letter of September 13, 1952, in which she summarizes some of her unique studies in this field:

"Any brief summary of these data is necessarily inadequate, and the generalizations require qualifications; but certain differences among these groups of scientists show up, both on the test material and in the life patterns. These are most striking in interpersonal relations, in the handling of anxiety and aggression, in the patterns on intelligence tests, and in the use of imagery.

"The typical physicist and biologist grew up with a minimum of group social activity, entered into heterosexual activities rather late and is now not much interested in any social activities. The psychologists and anthropologists for the most part were early conscious of their own and the family's social status, began dating early and enthusiastically, and are still enormously involved with other persons, one way and another. Both physicists and biologists show an unusual independence of parental ties, without guilt; and present attitudes toward the father are characteristically respectful, but lacking in closeness. Attitudes towards the mother are variable. Many of the psychologists and anthropologists, on the other hand, went through periods of great family dissension, and are still angry with or disparaging of their parents. I am sure it is significant also that in the families of these groups, the mother was most often the dominant character. This was rare in the other groups.

"The biologists, as a group, rely strongly and effectively on rational control. This appears in their lives, in their general unaggressiveness and in their unproductiveness and intense concern with form on the Rorschach. The physicists have a good deal of free anxiety, shown in their behavior and on the Rorschach, particularly in the large amounts of K and k. This is better controlled among the theoretical than among the experimental physicists. The *difference* between biologists and physicists is like the difference between compulsive obsessives and anxiety hysterics (I do not imply that all biologists are obsessives and all physicists hysterics). I am quite sure that there are relationships, of a nature still obscure to me, between the preoccupation with space, the type of symbolization that physics uses (which has spatial concomitants) and the choice of physics as a profession; but I suspect that in so far as space symbolizes distance from other persons (as Schilder says) it is more comforting than anxiety-arousing for these men, and I do not believe

that their disinterest in persons is always compensatory. The psychologists and anthropologists are enormously productive on the Rorschach, quite unconcerned with rational controls for the most part, and intensely preoccupied with persons. Their handling of anxiety is quite varied; but as a group they are much the most freely agressive, and this often has strong oral elements.

"The level of intelligence of my group is extremely high, but there are interesting differences in patterning: the theoretical physicists surpass the others on both verbal and spatial tests; experimental physicists tend to be low on verbal and high on spatial; anthropologists are high on verbal and low on non-verbal; psychologists are high on both; biologists show all combinations, but generally the geneticists and biochemists are relatively higher on non-verbal and the others reverse this.

"Differences in use of imagery during thinking are also fairly sharp. It is not easy to get a good report on this, and I am not happy about my data; yet they are remarkably consistent. In their conscious thinking, biologists are chiefly visualizers; among physicists the experimentalists rely most often on visual imagery, and the theorists on symbolization (usually mathematical and closely allied to verbal symbolization) or imageless thought. Psychologists and anthropologists rely predominantly on auditory verbal thinking. It occurred to me that it was possible that whatever process was most relied upon during the day would be the one to show up in hypnagogic revery. For those who are strongly visualizers or verbalizers, hypnagogic imagery is usually but not always in the same mode; for those whose dominant mode of conscious thought is symbolic or imageless it may be visual or auditory or symbolic, but usually with other twists to it. It would be interesting to find out if there are similar differences in the dream process.

"I should add that the one thing which characterizes every one of my groups of eminent scientists is the high degree of ego-involvement in the vocation, both now and earlier. That this is the major factor in their vocational success seems highly probable; but without a comparison group of less successful scientists I can't be certain about this. The ways in which this came about and the situations that made it possible are, of course, extremely varied. In some instances I can demonstrate quite direct relations between professional activities and specific emotional problems. In others I cannot; and I am not convinced that a genuinely neurotic problem is always involved. But I am convinced that it is the matter of personal involvement that is significant for problems of vocational choice and success."

I have included this long excerpt in spite of the fact that the researches of Dr. Roe in this area are still incomplete and inconclusive—as she herself points out—because even her tentative conclusions are unique, exciting and suggestive, and also because her work gives us an indication

of how great an investment of time, effort, personnel, and money an adequate study of this problem would entail [8].[4]

The Influence of Unconscious Symbolic Processes on the Production of Logical Thought and Logical Error in Scientific Research

It is obvious that conscious emotions which are close to the surface can influence a man's scientific work, especially perhaps those anxious ambitions and pettier jealousies which are bred by certain special economic and professional insecurities which will be discussed in Part II, and which may induce a young scientist to push for quick and showy results. Of far greater importance, however, is the subtler influence of streams of unconscious feelings which may be represented symbolically yet compulsively in the scientific activity of an individual, just as they are represented in neurotic symptoms and in dreams, or in all artistic and literary creativity. At this point, therefore, I must explain what the concept of symbolic representation means in this connection.

The symbols by which we think are multivalent tools, always representing many things simultaneously, some conscious, some preconscious, and some unconscious. In logical thinking, the conscious and preconscious symbolic processes represent external reality without disguises; what we call "logic," therefore, is in essence a coding of relationships which are inherent among such internal and external data as are accessible to our direct perceptual processes. One might almost say that although logic resides in the mind, its roots are in the relations among external facts themselves. It is a neglected consequence of this principle, that it is literally impossible to be "illogical" about accessible data except when one has an unconscious axe to grind. Failures in logic are a measure of man's capacity to deceive himself with unconscious premeditation, by misperceiving observational data and by misusing conceptual data for his own unconscious purposes. Many years ago William Alanson White warned that when anyone says that two and two are five, he does so because he has to; and that the way to meet this problem is not to teach him to say by rote that two and two are four, but to discover with him why he needs to believe otherwise.

It is an inevitable consequence of these facts that in spite of any degree of intellectual brilliance, individuals whose psychological development has been distorted by unsolved unconscious conflicts will have significant limitations in their capacity to build concepts out of the accessible data of external reality. This, indeed, is the greatest psychological hazard of the young intellectual—the fact that unconscious emotional forces persist in him in the form of unconscious needs and unconscious conflicts over these needs. In some, these forces will be expressed in obvious neurotic symptoms. In others, they cause subtle distortions of patterns

[4] Dr. Anne Roe, *The Making of a Scientist,* Dodd, Mead & Company, New York, 1953.

of living. Sometimes they are expressed in distortions of artistic or intellectual (in this instance, scientific) activities. Naturally there are varied combinations of these three alternatives; but it is an impressive paradox that among individuals in whom unconscious problems are expressed in obvious neurotic symptoms their scientific work frequently escapes the distortions which occur in other scientists whose unconscious processes have no outlet through overt neurotic symptoms. This is not always the case; but it is frequently true that the masked influence of unconscious psychological forces can warp the thinking of a brilliant investigator even when he shows no overt neurotic quirks.

Let me give a few brief examples of the operation of unconscious conflicts on scientific work and scientific careers.

I have known scientists of great ability whose work nevertheless always tended to be vague and ambiguous. Some of these men unconsciously designed their laborious experiments so as to prove nothing. For unconscious reasons they could not allow themselves to find out the answers to their own scientific questions. Such an unconscious conflict over seeing and/or knowing with a preponderant unconscious need *not* to see and *not* to know, arises in early years. In adult life it accounts for some tragic failures among scientists of brilliant capabilities. This conflict can also produce nihilistic critics who, however brilliant, may also be essentially destructive. For them it is as though seeing and knowing were transgressions which were endlessly tempting but always forbidden in the end. It is conceivable that adequate psychoanalytic therapy early in their training might have saved at least some of these gifted yet wasted and unhappy lives.

Experiments under hypnosis have demonstrated that unconscious processes can take over the intellectual equipment of a scientist and misuse that equipment for their own unrecognized purposes. Under post-hypnotic suggestion, for instance, highly skilled and experienced mathematicians have been led to attempt to prove theorems which they knew to be absurd or to solve mathematical problems which were known to be insoluble. This is the same type of process by which unconscious conflicts and purposes can lead a neurosurgeon to misapply his technical skills, or by which the subtle reasoning of a chemist or physicist, or the ingenuity of a clinical psychologist in devising or interpreting psychological tests, can be misapplied. Actually this is no more mysterious than is the way in which unconscious processes regularly exploit the need for food or the conventional impulse towards cleanliness. One will find in the literature of psychoanalysis many studies of the effects of unconscious processes in disturbances of various normal activities such as eating, washing, dressing, painting, writing, sports, play, sleep, sex, and excretion; but to my knowledge there are no similar studies of the power of unconscious processes to disturb the equally symbolic methods

of scientific research. Yet the surreptitious influence of these forces on scientific activities may determine the success or failure of an entire life [3].

That ancient tragedy of human nature, the success which brings no joy with it, occurs at least as frequently in the life of the scientific investigator as in art and business. A life of fruitful scientific exploration may end in a feeling of total defeat, precisely because in spite of scientific success the unconscious goals of the search have eluded the searcher. Sometimes at the end of a career this need to reach some still undefined goal has led a successful scientist to turn to a pseudo-scientific investigation of the supernatural. More often it leads to depression and a total arrest of all scientific productivity. Sometimes success breeds panic directly, as was observed in the case of a graduate student in physics, a man of outstanding ability, when the head of the department came up behind him in the laboratory one day, and said, "You handed in the best ——— examination I have ever received." Thereupon the student laid down his apparatus and left the laboratory in a panic, which prevented his returning for several weeks.

When they operate below the level of conscious awareness and therefore are not subject to conscious control and direction, the early patterns of familial loves and hates, of submissions and rebellions, may exercise a profound influence on the later work of a scientific investigator, even to the extent of determining his choice of science as a career, his field of work in science, the problems he chooses, the causes he espouses, and the very experiments which he undertakes. While this fact has long been acknowledged, it has never been appreciated in sufficient detail.

There is, for instance, the force of unconscious imitation, to which all of us are liable, imitation even of those very traits against which we may have rebelled most vigorously in childhood. Manifestations of this, both gross and subtle, occur all around us and in every aspect of life. There is the child of the alcoholic who hated the parent's alcoholism yet becomes an alcoholic. There is the child of a parent with a tyrannical temper, firmly resolved never to raise his voice in anger against his children, yet who hears his father's voice issue from his own mouth, as he yells at his three-year-old son in an automatic imitation of the voice and manner which he had always hated in his own father. A famous professor of biochemistry in one of our leading medical schools was the son of a fundamentalist minister against whose narrow ranting he rebelled. Yet the son spent an entire afternoon ranting, as his father was wont to do, but this time it was against the gentle religiosity of a hapless salesman of scientific apparatus who visited his laboratory. This same professor used every biochemical controversy as a pulpit from which to expound sarcastic diatribes against his colleagues, quite like the paternal sermons which had offended him during his childhood.

Also in rebellion against a fundamentalist background, a famous professor of psychology showed a missionary zeal in defense of a mechanized concept of human behavior, so narrowly partisan, indeed so "fundamentalist," that in essence the concept destroyed the value of his whole theoretical approach, which could otherwise have been of considerable scientific significance. Again, there was an eminent physiologist whose desiccated approach to certain problems bore the destructive imprint of an early conflict over whether or not to join the priesthood.

Such thought-provoking reactions are not rare. Many more examples could be cited, but they would merely serve to illustrate again the fact that the human beings who do research work are the subtle and complex instruments of their unconscious and conscious processes; and that the very content of a scientist's investigations as well as his vulnerability to the emotional stresses of research will reflect in varying manner the influence of those psychological forces which are unconscious residues from the unresolved neurotic problems of his early childhood. This fact indicates that an essential element is left out of the training of Man the Scientist, namely, an opportunity to free himself from bondage to the unconscious residues of his own childhood.

Summary

Research is a strange and challenging occupation for any young man to contemplate. We still know far too little about the unconscious components of the forces which lead a man or woman to go into research, or about the influence of the unconscious elements in determining the success or failure of his efforts. All of these problems, with their general as well as their special human significance, should be explored. How to do this is a matter for special consideration, since it presents many difficulties. Perhaps the first step would be to subject to psychoanalytic exploration, and in selected instances to psychoanalytic therapy a random sampling of: (1) promising young men who hope to make scientific research their life work; (2) men who have already devoted many years to research, including (*a*) men who in spite of high native endowments have been unproductive, (*b*) others who have been creative but who have ended up nonetheless in frustration and despair, and (*c*) finally those who have succeeded and who have enjoyed fully the fruits of their achievements.

Just as psychiatry has had to study elations in order to understand depressions, so in such a study it would be important to keep in mind that it is just as important to study successes as failures. In science as in other fields, success or failure cannot be accounted for by differences in intellectual capacity alone. Consequently, an analytical study of those who succeed and of those who fail and of the many gradations between success and failure would be of value not only to science but also to those

foundations and universities that wish to use men wisely to advance the frontiers of human knowledge.

To uncover in this way some of the unconscious factors which determine the choice of a career, and to explore the subtler forces which determine whether or not that career will be externally productive and internally fulfilling, would be a major contribution to human wisdom. To the best of my knowledge no such study has ever been made of any occupational or professional group. A start must be made somewhere, and in view of the paramount importance of science in today's world, it might be appropriate to start with scientists. Such an enterprise would merit the support of scientific foundations. The sums which are spent on research are so huge that it would seem to be common sense, business sense, and scientific sense to study the men who expend these investments.

It is probable that among the scientists who read this article, some may have developed articulate insights into unconscious forces which have helped to determine the choice and direction of their careers. If they will share their insight with me, I will be deeply indebted to them. They can do this by writing to me, either anonymously or preferably over their own signatures. I will regard all such data as professionally confidential communications, with the assurance to such readers that the material will not be used at any time without complete disguise, and not without specific permission and approval of the text itself by each informant.

Editor's Note: This presentation constitutes Part I of this paper. Part II is scheduled for publication in an early issue.

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