The Scientist in Contemporary Life

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bal) of the conditioned stimulus even when the experimenter informs the subject what the conditioned word was, to verbal recognition of the stimulus in more or less complicated forced-choice tests. Although it is perhaps unfair to anticipate future reports, it seems appropriate to mention that this *a priori* expectation is corroborated by direct experimental evidence.

References and Notes

1. This study was supported in part by a research grant (M-623) from the National Institute of Mental Health, the National Institutes of Health, U.S. Public Health Service.
2. W. N. Schoenfeld, in *Anxiety,* P. H. Hoch and J. Zubin, Eds. (Grune and Stratton, New York, 1950).
3. E. R. Hilgard and D. G. Marquis, *Conditioning and Learning* (Appleton-Century-Crofts, New York, 1940).
4. E. A. Haggard, *J. Exptl. Psychol.* **33**, 257 (1943).
5. G. Razran, *J. Psychol.* **2**, 327 (1936) ; *J. Exptl. Psychol.* **39**, 820 (1949).
6. ———, *Trans. N.Y. Acad. Sci.* **14**, 171 (1952).
7. J. G. Miller, in *Feelings and Emotions,* M. L. Reymert, Ed. (McGraw-Hill, New York, 1950).
8. R. A. McCleary and R. S. Lazarus, *J. Person.* **18**, 171 (1949) ; R. S. Lazarus and R. A. McCleary, *Psychol. Rev.* **58**, 113 (1951).
9. G. Razran, *Science* **90**, 89 (1939) ; B. F. Riess, *J. Exptl. Psychol.* **26**, 238 (1940) and **36**, 143 (1946) ; R. C. Wylie, *Generalization of Semantic Conditioning of the Galvanic Skin Response,* unpublished master's thesis, University of Pittsburgh (1940).
10. G. Razran, *Psychol. Bull.* **46**, 337 (1949).
11. C. E. Osgood, *Method and Theory in Experimental Psychology* (Oxford, New York, 1953).
12. G. Razran, *J. Exptl. Psychol.* **39**, 342 (1949).
13. K. Diven, *J. Psychol.* **3**, 291 (1937) ; *Certain Determinants in the Conditioning of Anxiety Reactions,* unpublished Ph.D. thesis, Harvard University (1937).
14. E. A. Haggard, *J. Exptl. Psychol.* **39**, 378, 861 (1949) : O. L. Lacey and P. S. Siegel, *ibid.* **39**, 122 (1949) ; H. Schlosberg and W. C. Stanley, *Science* **117**, 35 (1953).
15. J. I. Lacey, D. E. Bateman, and R. VanLehn, *Psychosomat. Med.* **15**, 8 (1953).
16. F. Wilcoxon, *Some Rapid Approximate Statistical Procedures* (American Cyanamid, Stamford, Conn., 1949).
17. C. White, *Biometrics* **3**, 33 (1952).
18. For zero preceding reinforcements, we compare reactions to the third and fourth words in the list. Reaction to these words, it will be remembered, were not included in deriving autonomic lability scores. To get zero points, however, the reactions were scored after the necessary basic statistics had been computed.
19. Comparison of unaware and aware subjects is made in another report: J. I. Lacey, R. L. Smith, and A. Green. *Psychosomat. Med.,* in press.
20. C. I. Hovland, *J. Exptl. Psychol.* **21**, 47 (1937) ; J. S. Brown, *J. Comp. Psychol.* **33**, 209 (1943) ; H. W. Hake, D. A. Grant, and J. P. Hornseth, *Am. Psychol.* **3**, 361 (1948) ; R. A. Littman, *J. Exptl. Psychol.* **39**, 868 (1949) ; J. A. Antoinetti, cited in C. L. Hull, *A Behavior System* (Yale Univ. Press, New Haven, Conn., 1952) ; D. D. Wickens, H. M. Schroder, and J. D. Snide, *J. Exptl. Psychol.* **47**, 52 (1954).

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IN a recent letter given wide publicity in the press, Albert Einstein states:

> If I would be a young man again and had to decide how to make my living, I would not try to become a scientist or scholar or teacher. I would rather choose to be a plumber or a peddler in the hope to find the modest degree of independence still available under present circumstances.

Einstein's letter was written in reply to a request for comment on the article "U.S. science: the troubled quest," by Theodore H. White, which was published in *The Reporter* on 14 and 23 September 1954. This is only one of many incidents that highlight the reaction of many scientists to the political and social environment in which they work.

Conversely, there are many signs of uneasiness on the part of others with respect to scientists and to scientific and technologic advance. The shadow of the A-bomb and the H-bomb hanging over the world like the sword of Damocles has intensified this growing distrust. At the recent conference on *Science and Human Responsibilities* at Washington University, E. H. Harbison of Princeton observed that "we have paid a heavy price for electric lighting, nylon, standardized radio entertainment, subways and airplanes, and the price has been a loss of spiritual values." Last year at a meeting of the American Philosophical Society, Lewis Mumford condemned physical scientists for failing to prepare society for the consequences of nuclear fission. He proposed a moratorium on science until society caught up. A few weeks ago I received a letter from the Science Council of Japan calling upon all professional societies to join in working for peace and mutual understanding by abolition of the A- and H-bombs. These are only a few examples of attitudes toward science, scientists, and the products of science which are widespread today.

It is essential for the welfare of both scientist and society that these unsatisfactory attitudes be corrected by mutual understanding and cooperation. The Cosmos Club, meeting ground of scientist, scholar, and humanist, offers them many opportunities to learn to know each other. I am taking advantage of one of these opportunities to set forth, with no claim to originality, a discussion of some of the sources of misunderstanding.

The contributions of science to mankind need no

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defense or apology. We live in an amazing age of science and technology. We have harnessed the energy of the physical world around us, steam, electricity, chemical reaction, and some nuclear reactions; we have erected towering cities, conquered barriers of space and time by automobile, train, airplane, telephone, and radio. Through science each of us may have the equivalent of 30 slaves sweating for him without the suffering and shame of human slavery. Each of us can rent 50 million dollars' worth of telephone equipment for 10 cents. Further exploitation of the physical world will in time bring new marvels of labor-saving devices, automatic factories, rocket airplanes, space ships, and the like. The weather may be adjusted to suit our needs or whims, perhaps not tomorrow, but some day. New drugs and advances in medical knowledge will further relieve pain and suffering. All these fruits of tomorrow's science promise to lift burdens and raise the standard of living of all of us.

The contributions of science not only have included the devising of powerful tools for altering the physical environment of man but also have made major contributions to our spiritual life. Science places a high premium on intellectual honesty and on objective truth, truth that can be tested by any man in any age. Science recognizes no arbitrary authority. It does not accept the laws of gravitation because of the authority of Isaac Newton. The laws of gravitation can be observed and demonstrated as a part of anyone's experience. The ethical ideals of the scientists are high. By the efficient tool of the human intellect, he has penetrated the mysteries of the material universe and freed the minds of men from ignorance and superstition. The successes of science and their impact on every aspect of life have captured the imagination and loyalties of many men as the only guide to truth.

But science is a partial view of life, in many respects a narrow view. There is often no more naive or gullible individual than the scientist outside his own laboratory and discipline. He tends to develop a myopic vision, and to the layman his interest seems to be in details remote from what most people consider the real interests and concerns of life.

Look at an all-too-common incident of life. A child dashes to the street; there is a shriek of brakes, a cry, and a small body lying in the street. The mother comes running, moaning, wringing her hands, tears streaming from her eyes. How does science describe this event? The physicist may compute the momentum and energy of the car, the forces exerted in the collision, the shock-absorbing quality of human tissue, the strength of bones. He may measure the intensity and frequency spectrum of the various sounds or the rate of generation of tears in the eyes of the mother. The chemist may analyze the tears and reveal the exact proportion of each salt in the water which is their main constituent. He may describe in exact scientific language the fibers of the handkerchief that the mother uses to absorb the tears. The medical specialist may describe the nature of each injury and identify the one that made death inevitable. Surely each of these is an incomplete view, although accurate and true. Surely each specialist confining his activities to those of his science misses the larger aspects of the event.

The cold sharp tools of science have not been effective in penetrating the area of human emotions, purposes, and values. "It is the Nemesis of the struggle for exactitude by the men of science" remarked the biologist, H. S. Jennings, "that leads him to present a mutilated, merely fractional account of the world as a true and complete picture." "You can no more analyze these imponderables by scientific methods" said Eddington, "than you can extract the square root of a sonnet." Science advances by purposely taking a limited and incomplete view of complex events.

Science is not only a partial view of life but it is amoral. There is no moral significance inherent in high explosives, chlorine gas, or nuclear energy. Without high explosives we would not have the plentiful supply of minerals that are the foundation of our civilization. The same high explosives can be used to destroy buildings, bridges, and human beings. Chlorine gas is the basis of common bleaching agents, which make possible your white shirts. It is also a potential tool of chemical warfare. An H-bomb, releasing the explosive force of millions of tons of TNT along with searing heat and deadly gamma rays and neutrons, can destroy a whole city. Yet the potentialities of nuclear energy for benefit to mankind are as great as its potentialities for destruction. We have only begun to explore its peaceful uses. Certainly an H-bomb will not and can not fall upon us until some member of our human race loads it on an airplane and until, at the right instant, some human being pulls the bomb release handle that sends it on its way.

The knowledge obtained in the biological and medical sciences is equally amoral in character. The accomplishments of psychology and psychiatry may be applied for beneficent, selfish, or evil purposes. Modern advertising, and other propaganda, communist brain-washing—all utilize knowledge of human behavior. The knowledge of the causes of disease assists in its cure or in its spread to others. Scientific knowledge is power, but it is power to be used for good or for evil as men choose.

I think that this amoral character of science is the source of unrest of the average man with regard to the scientist and his science. What kind of men and women will control the use to which the great power of science will be put? Will they be creatures of intelligence and understanding? Will they not imagine the consequences of the waging of war with the new A- and H-weapons, and will they not in horror refrain from their use?

The memory of recent history reminds us that the misuse of the products of science for human destruction is not checked by intellectual achievement. The ability of the human mind can be perverted to evil purposes. Perhaps no nation has ever reached such

eminence in science and engineering as Germany, but this did not save her from evil leadership. The concern of laymen is with the ideals of men in authority as well as with their ideas and their intellectual accomplishments.

At the conference on *Science and Human Responsibilities* previously mentioned A. H. Compton spoke on "Man's hopes and the new need for human responsibility." He saw much hope for the future of man because man "is a being of spiritual aspiration, of human feeling and emotion." To Compton

> . . . the hope for the longer future lies in a growing understanding of the conditions for the good life of man in a world of science and technology, and the acceptance of a morality that is consistent with these conditions.

I believe that many scientists are now fully awakened to their moral and spiritual responsibilities. As was well expressed by Robert Oppenheimer, the scientist has known sin. He has seen his greatest conquest of nature applied to kiloton and megaton bombs to destroy other men. If the scientist fails to take a hand in the decisions, there are many self-confident and ambitious men who are not hampered by too much knowledge and who will not hesitate to make decisions, not on the basis of the scientist's experience or on the basis of moral values, on considerations of right and wrong, but on the basis of social and political expediency or for purely selfish reasons.

I am not one of those few who believe that we can yet abolish the use of force in the world. Its presence is an evidence of our failure, but policemen are still necessary and they must sometimes use force. As a nation we find it necessary to build great military power. I am confident that, at the present moment, such strength is a greater contribution to the peace of the world than military weakness is. Certainly those of our people who fear science most would have been the first to criticize U.S. science if the U.S.S.R. had been the first to develop A-bombs.

The scientist has come to realize that outside of his laboratory he is a man like other men, with human passions and shortcomings as well as noble aspirations and high ideals. If you have doubt of this, I suggest that you read at least some of the 992 pages of testimony in the Oppenheimer hearing. To paraphrase Shylock, as did Ley in his scientist's code of ethics: Hath not a scientist eyes? Hath not a scientist hands, organs, dimensions, senses, affections, passions? Fed with the same food, hurt with the same weapons, subject to the same diseases, healed by the same means, warmed and cooled by the same winter and summer, as other men are? If you prick us, do we not bleed? If you tickle us, do we not laugh? If you poison us, do we not die? And if you wrong us, shall we not revenge? If we are like you in the rest, we will resemble you in that.

Scientists, as well as others, have come to realize that atrophy of the moral and spiritual life is inconsistent with well-rounded development. Man's life at its fullest is a trinity of activity—physical, mental, and spiritual. Man must cultivate all three if he is not to be imperfectly developed. Even after thousands of years of education and religious heritage, we see far too many of our fellow-human beings living the life of animals with sole interest in the physical and sensual and exhibiting primitive minds and souls. We find a few religious fanatics who are creatures of instinct and emotion with no guidance from reason. We find many who worship reason and the intellectual life, who appear to normal men as egotistical, selfish, and soulless mechanisms. Scientists in their professional activity elevate the faculty of reason, raising it from the elemental reasoning of animals to lofty creative genius. But to cultivate reason alone and exalt it to a religion or philosophy is as monstrous as to cut off one's arm or to destroy sight and hearing. For the area of human emotions, desires, purposes, values, feelings of beauty and ugliness, love and hate, also can ascend from beastly emotionalism to lofty dreams and aspirations.

The responsibilities of scientists for the proper use of scientific knowledge for human welfare are thus the same as those of other citizens, no more, no less. Scientists and other citizens look to the wisest among us, whether scientist, humanist, statesman, or bishop, for leadership in solving the difficult problems of meeting this joint social responsibility. We demand of these leaders not only intelligence to consider and integrate the specialized knowledge of all the arts and professions but high moral and spiritual standards as well.

Let us now turn briefly to some of the factors that have produced uneasiness on the part of the scientist with regard to his government. At the risk of oversimplification I will mention the growing administrative control of the Federal Government over scientific research, the ADX battery additive case, the introduction of security-risk considerations in grants and contracts for unclassified research, and some implications of the Oppenheimer case.

No more than 20 years ago basic scientific research was conducted chiefly by independent scholars at universities and nonprofit institutions with the modest funds realized from endowments or grants from foundations. Last year the Federal Government contributed to universities and nonprofit institutions roughly three-fourths of the total funds available to these institutions for scientific research. American science has thus become largely dependent on government. Both science and government have greatly profited. Nevertheless, the government is large and science is supported by many agencies. Administrators are not all wise men, and they change frequently. As in most areas of life, he who pays the piper calls the tune. Various consequences of this elemental fact worry the scientists.

In the first place it is much easier to obtain support for applied research, which leads to the practical development of new weapons, drugs, or fertilizers, than for the search for new knowledge. Many administrators, like the ordinary layman, believe erroneously

that, with enough men and facilities, any practical goal may be reached, even when the basic scientific facts are unknown. The truth is that most practical developments rest upon a foundation of basic scientific truth, of ideas developed by men seeking to understand nature. The scientists are convinced that faster progress can be made in applied research by a more generous support of basic research. Scientists fear that basic science is not receiving adequate support and point to the relatively low appropriations for the National Science Foundation as compared with those for applied science. They fear the changeable policies as administrators change. They fear the loss of independence in the conduct of their work. The remedy for these fears is wise administration and sound national policy.

I do not have the space to pursue other aspects of this subject, such as the effect of the large government expenditures on applied research and development in enticing scientists from basic research and from the teaching profession into much more lucrative positions in industry.

The ADX battery additive case disturbs scientists. Science has frequently encountered strong differences of opinions and rivalries, but it settles them by the unquestionable test of observed experimental results. Its findings are based on objective results, with great care to remove bias and prejudice and to secure accurate results. It sees in the ADX case an appeal to politics and to expediency. It contends merely that the merits of a battery additive cannot be settled by the testimonials of laymen or by a political vote. As science, it expresses no judgment on whether the product should or should not be offered in trade.

Still another incident described by Theodore H. White in the article previously referred to is the introduction of security-risk considerations in unclassified grants and contracts. Quoting from White:

> Slowly the administrative masters of the keys have begun to regard funds for science as a favor, a privilege of the patron to give or withhold depending on a man's high-school associations, his choice of friends, the remarks of his brother-in-law.

White tells of an instance in which a grant was withheld when applied for by a certain scientist, but assurance was given that the grant would be approved if applied for in the name of his laboratory assistant.

Still another source of worry is the implication of the Oppenheimer case and, particularly, the attention and debate with respect to Oppenheimer's attitudes toward the thermonuclear bomb and continental defense. White tells of an interview with a young doctoral student who expressed his assessment of the risk of working for the government in these terms:

> It's a hell of a thought to think that you go to work for the government now and fifteen years later any politician can pull the noose around your neck just because he didn't like the clubs you joined at school.

In spite of the uneasiness felt by many scientists with respect to governmental actions and public attitudes, I am convinced that most scientists recognize the source of many of these actions and attitudes in the stresses and strains of the cold war. Most scientists do not wish they had become plumbers. Most scientists accept the necessity of secrecy and security measures in certain areas of science. They realize the necessity of advancing science faster than our enemies and are concerned about our short supply of scientists in training, our shortage of teachers of science in high school and college, our unrealistic selective service policies. They wish to break the shackles that impede our scientific progress, especially in its creative and original aspects. In this task they ask for mutual understanding and assistance of their fellow-citizens.

News and Notes

Communication of Research Results

The Communication of Research Results, a symposium sponsored by the American Institute of Biological Sciences Publications Committee, took place on 7 Sept. during the AIBS annual meetings in Florida. James Bonner (California Institute of Technology) skillfully served as chairman of a program designed to explore new ways of meeting the serious situation that has developed in the publication and assimilation of our ever-expanding research literature.

William R. Duryee (National Cancer Institute), chairman of the AIBS Publications Committee, opened the session with "A blueprint for streamlining biological journal publication." With more than 20,000 biological journals appearing regularly and the number steadily growing, even the abstracting services fail to cover more than a small fraction of the material printed. (*Biological Abstracts* includes some material from less than 2000 journals and complete coverage of only 800.)

The AIBS has established a Publications Plan that looks forward to a reorientation of research publication by 1960. This involves the following steps: 1955, gather ideas from editors and biologists for solving the problem; 1956, formulate a workable and acceptable plan; 1957, promote coordination among the various indexing and abstracting services, with the development of a single standard numbering and indexing system as a prime objective; and 1958–59, promote number coding of articles to allow for machine searching of material, and work with journals to encourage them to simplify titles, shorten papers, and voluntarily send abstracts to *Biological Abstracts.* The ob-