Cognitive Dissonance: Its Use in Science

A scientist, like any other human being, frequently holds views that are inconsistent with one another.

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The term *cognitive dissonance* has been used by Leon Festinger (*1*) to indicate the existence of incompatible beliefs or attitudes held simultaneously by a human being, and in this respect scientists turn out to be human. The dissonance may be unconscious, and indeed it usually begins in that way. Some event, however, may make you conscious of the incompatibility, and then there you are, convicted, to your own knowledge, of rank inconsistency —convicted because the culture still insists, long years after the age of reason, that it is reason which yields truth and that contradiction is rationally insupportable. You like to smoke and do, and yet recent events convince you that smoking carries a hazard of lung cancer. You accept both the Christian ethic that the meek should inherit the earth but also the ethic of chivalry that sullied honor must be avenged. How can you manage then to give rationalism its due? Festinger says that (i) you change your behavior (stop smoking) or (ii) you change your cognition (pooh-pooh the scare about cancer) or (iii) you suppress or ignore the dissonance (forget that Jesus condemned war) or (iv) you do something in between, like rationalizing, distorting the cognition. But science? Is not science the inexorably rational enterprise? Does it ever condone dishonesty? Does it not oust dissonance just as soon as it becomes aware of it? Let us see.

The Geister

There is a new history—or at least Count Tolstoy (*2*) said there is, 95 years ago—one that looks below men's ready consciousness to deeper forces that control their acts and opinions. One of these forces is the current of credence, the stream of change in what the culture carries as the truth at any particular time, or at least as the generally accepted opinion. Goethe called this influence the *Zeitgeist* (*3*), and recently the term has come into more common use as the new Tolstoyans see how the climate of opinion affects thought and action, now this way and then presently otherwise.

The paradigms of science—that is T. S. Kuhn's word (*4*) for the fundamental hypotheses—are in the *Zeitgeist*—in biology, for example, special creation once and then natural selection later. Scientific revolutions change the *Zeitgeist*—the big changes, Ptolemy to Copernicus; the little ones, Galton to rediscovered Mendel. The *Zeitgeist* is also the most plagiarized source of information and attitude, but then of course ideas have to come from somewhere. Surely the age-old belief that the "originality" of genius is a kind of intellectual spontaneous generation, surely that faith in the existence of uncaused thinking is passing.

The *Zeitgeist* can, of course, be conscious or unconscious. Goethe believed in it as unconscious, quite possibly because he thought of its effect upon the thinking of genius as insidious, for it is always there, often secretly sapping the defenses of originality.

Time is not the only parameter in respect of which these insidious forces change. There are several other well known *Geister*, if I may try to enhance attention by continuing to use these not very lovely Teutonisms. There are *Ortgeister*, the national habits of thinking. The psychologists know how much better subjective introspection still fares in Germany than under the dialectical materialism of the Soviets. Certainly the political climate of opinion is not quite the same in Alabama as in Maine, nor was the difference the same in 1960 as it was in 1860. The *Fachgeister* in science are the intellectual forces that differ between schools—a century ago between the vitalists and the mechanists. These prejudices shade over into the individual preferences, which might be called *Eigengeister*—Johannes Müller and Helmholtz, Louis Agassiz and any good Darwinian or Darwin himself. It is a convenient vocabulary if one does not take it too seriously.

Occasions for Dissonance

Festinger notes that any serious decision, made to resolve a doubt when no additional evidence becomes available, creates dissonance. The 50–50 decision, as you review the evidence under the necessity for making a choice, may change to 60–40, and then you act—you may have to—on the 60, knowing well that there still exists a good argument in back of the 40. With the choice made, the healthy person forgets about the weaker alternative and, if the consequence proves the result of the choice to have been wrong, still a mature mind maintains: "But the choice itself was right even though the result was unwanted; all I had to go on was the 60–40, and 60 is more than 40." The business of living is coping—says Karl Menninger (*5*), ably supported by Samuel Butler (*6*)—and the refusal to worry over a persistent cognitive dissonance is a symptom of effective living.

Now let me place in the record seven instances of occasions on which the scientist proceeds in the face of cognitive dissonance, sometimes aware of what he is doing, sometimes not, sometimes suppressing into unawareness a rejected alternative, sometimes, on the other hand, consciously achieving resolution of his dilemma by changing his opinion. My argument is that the investigator is often made more effective by his pushing the contradiction aside and his going on with whatever busi-

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ness he has in hand. His refusal to worry is not immoral. He had chosen a prescribed universe in which to work and it is best that he carry through to whatever goal he had in mind, letting others (and most especially posterity) judge whether he shut his mind to the wrong things.

Paradigms

A paradigm is a fundamental hypothesis or model in respect of which scientific thinking occurs. A change in an important paradigm constitutes a scientific revolution (*4*). Everybody knows about the great instances: the geocentric system of Ptolemy versus the heliocentric system of Copernicus; the pendulum as a constrained falling body for Aristotle versus the pendulum as a freely moving body for Galileo; Newton's addition of attraction as a characteristic of all matter; special creation versus natural selection. A moot revolution is still in progress, a gift of Descartes to psychology: the dualism of mind and matter versus the physicalism of both mind and matter as demanded by modern positivism.

A paradigm is a way of perceiving nature, and, as in all perception, the shift from one hypothesis to another is all-or-none. There are no intermediates. That camel in the field suddenly is seen for what it is, a pile of stones. The textbooks of psychology give ambiguous figures to illustrate this point —the duck-rabbit which is perceived as one or the other but never as both together, or the old-lady-and-the-young-lady, which alternates, the ribbon on the young lady's neck shifting instantly to become the old lady's mouth, and so with the other features. The change is abrupt. In the thinking of an individual it must at any moment be sudden, from the duck to the rabbit, from special creation to natural selection.

The cognitive change between these alternatives of a paradigmatic dissonance is sudden, but the historical change is slow, both in the body of scientific belief and usually in the individual's thought. There is no contradiction here. It was a long time from Copernicus to Galileo, and the general understanding and acceptance of the heliocentric theory took even longer as learned belief edged over toward the new view. The gradual change is measured by an opinion poll, as it were. Darwin spent many years weighing the alternatives for evolution in his mind.

A scientific theory is a policy, said J. J. Thomson (*7*), and when a revolution is on—as it is just now in respect of the dualism of mind and matter—choice of a preferable faith is hard. Eventually the victorious new belief drops down into the stream of the *Zeitgeist* and is carried along, unconsciously, for the most part, and fundamental to the thinking of most wise men until something new happens. These paradigms are, however, faiths, the consequences of decisions. The policy that resolved the dissonance has merely pragmatic truth-value in that it works best, at least for the time being. Relativity theory made both the heliocentric theory and Newtonian mechanics less sure.

Eponyms

The conventional view of the history of science is that science advances gradually by the hard work of many investigators but that its course involves sudden spurts when someone, who is eventually to become known as a "Great Man," has a revolutionary insight or makes a crucial discovery which changes the speed or direction of progress in scientific endeavor. If the change is radical enough, the Great Man, after he has been recognized as great on account of his contribution, has his name put down upon the discovery or the theory or the resultant school of thinking, and thus becomes an Eponym. Aristotelian thinking, the Copernican theory, Newtonian mechanics, Cartesian dualism, the Darwinian epoch, and Mendelian inheritance are all examples of eponymous thinking.

Even while we admit that some men make habitually greater contributions to knowledge than others and note that feeble-mindedness has done little to advance science, careful consideration must lead to the conclusion that eponymity is mostly a delusion—the Great-Man theory of history, as it used to be called when William James (*8*) and Herbert Spencer (*9*) were disagreeing about its validity. The course of science is gradual and continuous, as the occurrence of multiples in discovery and invention proves, for almost always the "great discovery" has already been anticipated—perhaps less assuredly or else with inadequate publication. Multiple discovery is, however, the rule, and often discoveries are practically simultaneous, as the evolving *Zeitgeist* finds itself at a given stage realized through more agents than one (*10*). Lancelot Whyte thinks that it takes about 200 years for the maturation of a new paradigm—at any rate he traces the gradual acceptance of Freud's paradigm of the unconscious from 1695 to 1895, when Freud provided a previously weak belief with enough stamina for it to stand alone (*11*), believed by a minority of intelligent minds—and then later by a majority.

Why does eponymity occur? In part because men are hero-worshippers. We hear enough about the conflicts that arise because human aggression makes too many men want to lead, but not very much about followership, the human need for heroes (*12*). History does, moreover, need help to be understood. It is too multifarious for man with his limited spans of attention and memory to carry in his mind. Eponymity performs the service of packaging history for handling, just as science itself is said to exist to promote economy of thinking.

For the most part the scientist and the historian of science simply suppress the unpleasant part of this cognitive dissonance. They need their beloved heroes and also their packages. Especially does the ambitious investigator on his way to recognition stand in need of his Eponyms, for his fantasies run toward eponymity for himself and he can hardly bear to reduce himself to being a mere agent of the *Zeitgeist*.

Freedom and Determinism

In the antithesis between freedom and determinism we see what is perhaps the best known instance of cognitive dissonance that the scientist encounters. Determinism is a paradigm which science has long accepted. Laplace held that if you could know absolutely all about the universe at some instant, then you could casually extrapolate to all its past and all its future (*13*). Of late the principles of uncertainty and complementarity have led physicists to doubt the universal usefulness of causality in particle physics, where statistical laws hold and a particular event is sometimes indeterminate. The difficulty here is operational: if you cannot observe the position and

momentum of an electron synchronously, does the one not exist whenever the other does, or do both exist at once although only one, either one, but not both, can be observed at one time? Can what is not observable exist? P. W. Bridgman said not (*14*), but this difficulty does not affect the fact that, in general, science asserts that causality and thus determinism are essentials of the orderliness of nature.

So in science the paradigm of determinism works well. It is a good policy for science. It is, however, dissonant with practical policies of living, and for 99 percent of his life the scientist is a human being, not only outside the laboratory but in his conduct of experimentation and in all his relations with people. Any social occasion that implies his own duty or responsibility is founded upon the paradigm of freedom. All morality and altruism and affection, as well as hatred and opposition, imply freedom. Language is shot through and through with the implication that men are free to choose. If ever a policy was justified by almost universal use, it is the theory that man is free to choose. He is even free to choose his paradigms, free to believe in freedom or free to believe he is not free.

The resolution of this dissonance which Kant even listed among the antinomies (*15*), becomes clear, however, once we accept the doctrine of paradigms. The scientist chooses the paradigm of determinism when he designs his experiment, when he theorizes, when he is thinking scientifically. As a practical man he needs to believe in his freedom and usually in the freedom of others, unless he is being a psychologist, when he may examine the behavior of a subject in respect of the conditions that determine it. It may be said that determinism is the broader and more positive paradigm, for its complement, freedom, is negative, consisting in a preference for ignorance. To believe that the "originality" of a Great Man is caused, as Herbert Spencer did (*9*), is to refuse to be content with ignorance, even when the causes cannot be actually discovered. To believe with William James that human dignity must be preserved by wresting some fraction of human behavior from the shackles of causality is to gain contentment without even a struggle to penetrate ignorance (*8*). The paradigm that asserts freedom is a negative paradigm.

In my thinking freedom is a preference for certain kinds of ignorance, but it has its scientific uses. It frees the investigator—as well as the historian—to think of effects and not to waste time worrying about causes which, if they exist, may still remain inscrutable by any means of observation available.

Multiples

The chief argument for the existence of the *Zeitgeist* and for the gradualness and continuity of the progress of science is the occurrence of multiples in discovery and invention (*16*). Discovery and new insight tend to be independent but synchronous in the minds of unassociated contemporaries. The great discovery or insight almost always turns out to have had a long history of somewhat less specific or at any rate less well publicized anticipations, a history extending through many decades or even a couple of centuries. Robert K. Merton gives us a convincing explication of this view, but by no means claims to be its discoverer, for he shows how this theory of multiples is itself a theory confirmed by its own history, and he lists more than a score of rediscoveries or reaffirmations of the theory between 1828 and 1922 (*17*). It was in 1922 that Ogburn and Thomas published their list of 148 multiples, mostly doublets (*18*). Merton with Elinor Barber has, however, studied intensively 264 multiple discoveries, finding 179 of them to be doublets, 51 triplets, and so on up to two discoveries, each of which was made independently nine times!

With multiples so common, a long list would be inappropriate here. Let me mention a few of the better known instances so that the reader will recall their nature. Napier and Briggs each independently invented logarithms in 1614. Newton and Leibniz warred over which of them was first in the invention of the calculus. Charles Bell in 1811 and François Magendie in 1822 independently discovered the law of spinal nerve roots, and Bell also in 1811 and Johannes Müller in 1826 formulated the doctrine of specific nerve energies which had, in a sense, been anticipated by John Locke. Adams and Leverrier discovered Neptune within a few days of each other in 1845 because the obvious thing to do then was to predict another planet from a study of the perturbations of Uranus. Helmholtz in 1852 found himself anticipated by Thomas Young in 1801 on color theory and gave him full credit. The most famous case may be Alfred Russel Wallace's independent formulation in 1858 of what was also Charles Darwin's theory of natural selection.

But, if multiples are the rule, why must Merton be at such pains to demonstrate what is being perpetually rediscovered? Because the rule establishes a major cognitive dissonance in the thinking of scientists. Merton has even written a paper on the resistance of scientists to a belief in multiples (*19*). The fact of multiples threatens the scientist's priority of discovery and thus his most carefully nurtured ambition, the demonstration of his own originality. The existence of multiples means that "originality" is at least in part externally determined and threatens the individual uniqueness. That is a threat to his identity, one that he cannot very well accept, and indeed it is a question whether the scientist's failure to orient his thinking with respect to this conclusion interferes very much with the quality and quantity of his contribution. His achievement may even be greater if he has enough channel vision to keep his eye on the main undertaking and so avoid distraction.

Egoism

Egoism is where the *Fachgeister* and the *Eigengeister* come in. The most prevalent generator of cognitive dissonance is surely egoism. In science the persistent dissonance-inducing dilemma is between pride and objectivity, a conflict so common that it has been called the scientist's motivational predicament. Important theories, marked for death by the discovery of contradictory evidence, seldom die before their authors, commented Max Planck (*20*), but why does not an author abandon his theory instead of turning traitor to science and retarding its advance? Because a theory which has built up its author's image of himself has become part of him. To abandon it would be suicidal or at least an act of self-mutilation. It is better to live with this fresh dissonance, suppressing new evidence from cognizance as far as possible.

Seldom over the ages has scientific controversy been impartial and judicious, with the energies of both parties concerned only with getting at the truth (*21*), but this is not the place

for an anthology of these quarrels, in which I assure you each antagonist defends and does not condemn himself. Let me provide just one illustration of a quarrel between two eminent German psychologists in the early 1890's over the question whether a perceived tonal interval is bisected psychologically by the arithmetic or by the geometric mean of its tonal stimuli. Wilhelm Wundt, the more vehement, was so angry that he said he "would speak without anger," hoping that his antagonist, Carl Stumpf, would learn to be more just to others and more severe toward himself (*22*). Stumpf, less vigorous and saying that he meant to be calm, nevertheless spoke of Wundt's "mixture of untrue assertions, confusions, mutilations of the course of my thought, obscure imputations and negligences, infirm evasions, fallacies of every kind, and frequent assurances of the incapacity and ignorance of his adversary" (*23*). When the pot calls the kettle black we are in the presence of dissonance.

Any reader of Kepler's biography will wonder how the three great planetary laws could have emerged from so inconsonant a mind, in which mysticism was mixed up with a passion for accurate observation, which perceived as one of its great intellectual achievements the spacing of the six planets in the solar system as related to the shape of the five regular geometrical solids, a mind which took astrology seriously, and which experienced ecstasy over both its true and false successes (*24*). There is, however, a lesson to be learned from emergence of great discovery from the many dissonances of Kepler's mind: enthusiasm that promotes indefatigability can sometimes achieve more than a complacent intellectual integration. Dissonance need not be lethal when the drive toward a goal remains fixed in spite of potential distractions. It is indeed a fact that potential distraction may sometimes spur attention to higher levels (*25*), and it would sometimes seem to be true that people who complain about distracting noise are really complaining because the noise keeps them on the *qui vive* so that, being unable to relax, they discover themselves in possession of new achievement (*26*).

The dissonance due to egoism gets resolved in science by a division of energies: the egoist furnishes the drive needed for research and a reviewer or commentator provides the objectivity that cuts the claim down to size. Sometimes objectivity is reserved for the insights of posterity; yet in other instances the dual role may be played alternately by the same person, now the fanatic but subsequently his own critic. Science cannot do without the drive, dissonance or no dissonance. Nowadays there is some evidence that this dissonance of egoism is being reduced by the explosion of science which forms investigators into teams and produces papers with multiple authors (*27, 28*). In spite of loyalty and group pride, a *nos* has less selfhood to defend than does an *ego*.

Ambivalence

Once again Merton supplies us with an idea and information about it. Scientists seem to hold many incompatible values simultaneously. Merton lists nine such instances and a half dozen of them I paraphrase here, with some of Merton's careful qualifications pruned off for the sake of simplicity (*29*).

a. Publish promptly
   BUT not prematurely;
b. Remain receptive to new ideas
   BUT resist intellectual fads;
c. Be erudite
   BUT do not sacrifice research to reading;
d. Teach the young researcher
   BUT do not sacrifice research to teaching;
e. Attend to details
   BUT ignore inconsequentials;
f. Accept tutelage from the wise
   BUT maintain your own independence.

Certainly these dissonances of counsel are not dangerous. They have the effect of warning the neophyte that wisdom is not to be had by simple guides but that success is for him who learns to sail a course safely between these buoys.

Merton's interest in ambivalence is centered chiefly on scientists' desire for priority, a dissonance between the pride of creation and the humility of the dedicated objectivist. Scientific morality teaches that it is the contribution that counts, not who makes it, and often the fanatical investigator accepts this view explicitly in print, pointing with pride to his modesty, as it were. Merton, however, gives it as "a rule-of-thumb" that "whenever the biography or autobiography of a scientist announces that he had little or no concern with priority of discovery, there is a reasonably good chance that, not many pages later in the book, we shall find him deeply embroiled in one or another battle over priority" (*30*). Merton goes on to cite his instances, not the least of whom is Freud, whose dissonance about priority he deploys at length.

In these dissonances there is nothing new to us. They are the case of Abraham and Isaac. To sacrifice one's very own brain child by welcoming a prior multiple is the supreme test, one that no father of an idea can easily undertake.

Personal Bias

Individual differences in values and attitudes are familiar subject matter for the psychology of personality, and the cybernetic interaction of dissents is one of the most important social dynamics for the advance of intellectual civilization. To conclude our list with personal bias as an important cause of dissonance is merely to assert again how important cognitive dissonance is in the welter of intellectual progress. Though it may be a hindrance to a little thought, it belongs in the matrix from which the big thoughts eventually emerge.

A good example of the prevalence of attitudinal dissonance is the phenomenon known as love—plain everyday heterosexual love. Your lady fair is your great delusion, so important that even courts of law recognize the essentiality of this personal bias in the social fabric and do not require one spouse to testify against the other, though justice be thereby refused.

Loyalty creates dissonance, loyalty to a school or a principle, carried often by the *Fachgeist*. Hatred creates dissonance, and the literature of controversy—the bitter controversies—carries those examples. There is no need to stress the obvious, and we can leave the bitter dissonances to the journals where the polemics can be found. Let me rather give here the record of two pleasant dissonances, published sentiment by two of psychology's eponyms on the occasion of the death of an admired colleague.

Chauncey Wright, a clear intellect who lived a life of brilliant thinking, and who evolved for the most part from conversational bouts with other top-notch minds in the periphery of Cambridge, Massachusetts, in the 1860's and early 1870's, was one of the forebears of pragmatism, for he stimulated C. S. Peirce, William James, Oliver Wendell Holmes, Jr., and oth-

ers, and they met constantly for conversation in what Peirce called the Metaphysical Club. Wright talked but did not publish. His influence was personal, and he died suddenly of a stroke in 1875 when only 45 years old. Of him William James then wrote (*31*):

> If power and analytic intellect pure and simple could suffice, the name of Chauncey Wright would assuredly be as famous as it is now obscure, for he was not merely the great mind of a village—if Cambridge will pardon the expression—but either in London or Berlin he would, with equal ease, have taken the place of master which he held with us. The reason why he is gone now without leaving any work which his friends can consider as a fair expression of his genius, is that his shyness, his want of ambition, and to a certain degree his indolence, were almost as exceptional as his power of thought. Had he, in early life, resolved to concentrate these and make himself a physicist, for example, there is no question but that he would have ranked today among the first few living names.

How could James know, how does anyone ever know, that a man with a change of personality would have been great, that by speculation one can say what change of conditions would transform the impossible into the actual? This was a loyal statement for him who defended the dignity of man against Herbert Spencer, although not for the writer of a textbook in which "every sentence had to be forged in the teeth of irreducible and stubborn fact." We may appreciate James's loyalty and note the dissonance.

Hermann Ebbinghaus, the German originator of the experimental psychology of memory who made a brilliant start and then left the field for others to develop, a lucid writer of a systematic textbook who completed the first volume but not the second, and an influential personality for over 20 years in the scene of German psychology, died in 1909 a few months before he was due to speak at the vigentennium of Clark University at which Freud and the other psychoanalysts first made their appearance in America. E. B. Titchener, the erudite, German-trained Briton, who was protector of the German mentalistic tradition in America, said in his address on this occasion (*32*):

> When the cable brought the bare news, last February, that Ebbinghaus was dead, just a month after the celebration of his fifty-ninth birthday, the feeling that took precedence even of personal sorrow was the wonder what experimental psychology would do without him. . . . What characterized him was, first, an instinctive grasp of the scientific aspect of a problem . . .; secondly, a perfect clarity of thought and language . . .; and thirdly, an easy mastery of the facts. I say mastery, but the truth requires a stronger word. There was about Ebbinghaus a sort of masterfulness; he never did violence to facts, but he marshalled them; he made them stand and deliver; he took from them, as of right, all that they contained; and with the tribute thus extracted he built up his theories and his system.

Titchener, graceful master of the English idiom, was of tougher fiber than James. You would hardly have expected this panegyric from him, and yet there it is as he was led away from facts to romance by his loyalty to an ideal. Ebbinghaus has remained "great" because he was the eponym for the experimental psychology of memory and learning, but psychology got along as well without him as it has without every other great figure that has passed on. History takes care of itself pretty well, and progress is not always aided by the longevity of eponyms.

The Economy of Dissonance

It is obvious that operating in the face of dissonance in belief and attitude is a characteristic of man, whereas the culture demands that man deplore that fact and that he strive always for his own consistency. It is interesting to speculate what life would be like if men could be computerized, each with an enormous permanent memory which could be almost instantly scanned before a new thought was added to the wholly consistent inventory of accepted truth. Frustration would be reduced, controversy eliminated, complacency magnified, and progress might be speeded up enormously, if complacency did not slow it down. As it is, man must be content to accept very considerable limitations in the range of his apperception and in the adequacy with which he can scan the traces of his past experience. He enlarges his range of thinking by the use of symbolism, letting a symbol stand for a complex, and another symbol for a higher complex of symbols. That is why language places man intellectually above the animals, and why mathematics is such a powerful tool in the extension of thinking. But beyond such means man has to make do, living with his dissonances because his brain does not give him the power to unify the universe of his thoughts. We have seen how he adjusts to dissonance: he remains unaware of it until the discrepancy forces itself upon him; then he may alter his belief and action, or he may suppress from ready cognizance one-half of the contradiction, or he may by rationalization rack the incompatibility into the conformity of a false resolution.

Is it the conclusion of this article then that scientists are human? No, the article says more than that. It is its conclusion that the major dissonance in science between the goal of consistency and the fact of persistent inconsistency is not, as a practical matter, resolvable. Dissonance is seen to become useful when it is understood as freedom for concentration on a limited enterprise, freedom to ignore the remotely relevant because apperception, limited always by its channel vision, sees for the time being only the main goal. The investigator may sometimes shake himself free of his concentration and criticize more generally the significance of his enterprise, and there are also other critics who will do it for him. At any rate, though scientific progress may be hindered by dissonance, it is not necessarily blocked, for there is always waiting off in the future that most objective of critics, posterity, as well as posterity's posterity.

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News and Comment

Goldwater: An Effort to Evaluate the Effects That His Election Might Have on Scientific Activity

For various reasons it is difficult to try to assess what effects a Goldwater presidency might have upon the federal government's far-reaching and intimate relationship with science and technology. This is not only because Congress, public opinion, and the complexities of public affairs often create a sizable difference between presidential desire and accomplishment, but also because it is politically sufficient for a candidate to present himself as "pro-science" without going into very much detail. This stance is aided by the fact that few issues involving science lend themselves to politically partisan formulations. In addition, Goldwater's designs for government represent such a profound departure from what has prevailed since New Deal days that there is no reliable way of evaluating their general effects on the country or their particular effects on the special interests of the scientific community. Nevertheless, there are some clues as to what might happen in the scientific and technical realm if the Senator should succeed to the White House.

The most significant, of course, is that Goldwater has emphatically declared himself for a more vigorous effort in military research and development. With the Defense Department's R&D budget now somewhere in the neighborhood of $7 billion a year, it would be difficult to argue that the military is not utilizing a generous share of the nation's scientific and technical resources, but the appetite of the military for new weaponry is understandably boundless, and there is no doubt that if substantially more money were available, it would promptly be put to work.

Whether an expansion of military R&D would have a detrimental effect on other fields of research is something that is fogged by the numerous unknowns of scientific and engineering manpower utilization and federal budgeting. The principal beneficiary of an expanded military effort would be the aerospace industry, which is currently suffering from excess capacity. This has been brought on by the administration's refusal to build a new manned bomber fleet and also by the approaching completion of the intercontinental missile force. Thus, it appears that a good deal of manpower and facilities are available for great new undertakings in the development and production of strategic weapons, but it is not at all clear that this could be accomplished without financial effects on some of the other programs that are lumped together under the budgetary heading of research and development.

Congress may eventually accept more realistic concepts when it comes to evaluating federal support for research and development but at present, the dominant tendency is to place a single price tag on the entire national scientific and technical effort. The resulting figure, now around $16 billion, tends to create pressures all along the line for economy and slower growth, and if the overall total were suddenly swollen by a major increase in funds for military research, it is not likely that innocent civilian bystanders such as the National Institutes of Health and the National Science Foundation would benefit. Ideally, these agencies should not suffer from an expansion of activity in remotely related fields, but things don't work that way; at least, they have not so far, even under an administration that has been prodding Congress to expand the budgets of the agencies responsible for financing basic research. Throughout the 1950's the boom in defense-related research had a beneficial spill-over effect, at least in financial terms, on the basic sciences, but that was before R&D had come to account for so prominent a part of the federal budget. Now that it totals some 15 percent of annual federal outlays, hard choices are being made and some worthy projects are being passed up or delayed for no other than financial reasons.

In any speculation on what fiscal fortunes might await science and technology under Goldwater, it is significant that the Senator in his public utterances and votes over the years, has reacted to the growth of the federal budget as the unholiest of developments. It is plain, however, that Goldwater's anti-spending instincts do not apply across the board, but rather apply to government expanding authority abroad and reducing it at home. The called-for boost in military research is one example of an exception to the