niques may help. "There is no question that patients can deceive you. The hospitals are full of patients deceiving their physicians. It's a very tough problem and no one knows what to do about it," says Loriaux.

Other likely changes at NIH are procedures to ensure that patients' previous medical records are not overlooked and periodic audits of randomly selected experiments to guard against protocol violations.

Whether these will make the volunteer program safer is hard to say. "I'm baffled by what we ought to do. I'm not sure we should jump around and try to do something. There is no easy solution," says Lipsett.—GINA BARI KOLATA

Behavioral Medicine: An Emergent Field

Using systems theory as a model, researchers are working toward a synthesis of knowledge from biological and behavioral sciences

"Behavioral medicine" is a term that is yet unfamiliar to most people, including many who practice medicine. To some it connotes preoccupation with physical fitness and stopping smoking. To others it is indistinguishable from psychosomatic medicine.

Behavioral medicine is an emerging field which treats mind and body as two ends of the same continuum. The core of basic research in this field is an attempt to locate the specific neurochemical mechanisms by which subjective states —specifically those associated with emotional stress—lead to disease. Ultimately, it is an approach to disease and health that spans everything from research through etiology, diagnosis, treatment, rehabilitation, and prevention.

Behavioral medicine got its formal send-off at a conference held at Yale University in 1977. It was there that participants made their first stab at defining the field, one later refined at a conference at the Institute of Medicine the following year. The early definition talked of applying knowledge from behavioral sciences to research and treatment of disease; the later definition embodies what they really meant, which is the integration of biological and behavioral knowledge in a multidisciplinary approach to the questions. The disciplines include anthropology, sociology, and epidemiology as well as psychology, psychiatry, medicine, and basic biological disciplines.

A result of the Yale conference was the launching of a new journal, the *Journal of Behavioral Medicine* in March 1978. In the same year was created the Behavioral Medicine branch of the National Heart, Lung, and Blood Institute, headed by psychologist Stephen M. Weiss, and the founding of the Academy of Behavioral Medicine Research, whose president is psychiatrist David Hamburg, the outgoing president of the Institute of Medicine. Weiss, Hamburg, and Neal Miller of Rockefeller University (called by some the father of biofeedback) were the prime movers in the formation of the society.

The most direct precursor of behavioral medicine is psychosomatic medicine, a field based on psychoanalytic theories about disease etiology which grew up in the 1950's and 1960's.

Psychosomatic medicine has made crude but perhaps crucial contributions to acceptance of the notion that the activities of mind and body are inseparable. For example, observers have tentatively identified "disease personalities"—constellations of traits that seem to have a high correspondence with such varied disorders as cancer, multiple sclerosis, arthritis, migraine headaches, diabetes, and heart disease. But correlation tells nothing about causation, and a schism developed in the field between those who were psychoanalytically oriented and the basic scientists whose roots were in psychobiology. It was the latter group that broke off to define the field called behavioral medicine.

This development was the natural result of new findings in biochemistry, which, as Weiss says, "prompted new ways of thinking about mind and body interactions." In traditional medicine, he points out, mind and body had to be dealt with separately "because no one knew enough about how the brain works." But findings in neuroendocrinology have offered some little windows into the mystery. They are linked to the discovery that the central nervous system and the endocrine system are connected in more complex ways than hitherto believed, as evidenced by the fact that some hormones have also turned out to be neurotransmitters. Such findings offer tangible links between brain activity and body functions which justify, in the opinion of behavioral medicine advocates, the defining of a new field. They felt that no one discipline was in a position to further explore these mysteries because of the bewildering interconnectedness of systems that is beginning to be revealed. As John Lacey of the Fels Research Institute said at a recent meeting of the academy, "psychoneuroimmunology could never have emerged from the field of immunology."

Behavioral medicine researchers like to talk about being on the verge of a "new paradigm" in medicine, a paradigm based on systems theory, which entails looking at everything in terms of feedback loops rather than chains of cause and effect. Whether or not the shift is as revolutionary as that expression implies, establishing the field marks a departure from the philosophy that underlies traditional medicine. Cartesian mind/body dualism still influences the practice of medicine as it also "plagued the early development of psychosomatic medicine" according to Weiss and Gary Schwartz of Yale University. Recognizing that all behavior is subject to the limitations of the organism and mediated by its biological substrate is hard for some people to accept, for taken to its extreme it implies biological determinism. But behavioral medicine also advances an expanded idea of individual freedom, which is supported by discoveries that the autonomic and voluntary nervous systems are entwined and that autonomic processes are far more susceptible to voluntary control than was hitherto believed.

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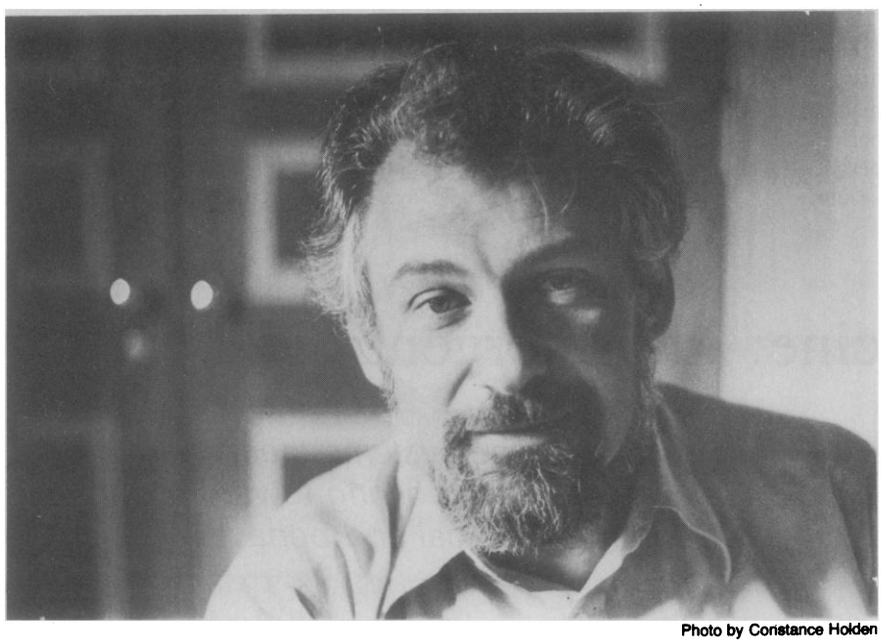


Photo by Constance Holden

Stephen M. Weiss

Currently the emphasis in the field of behavioral medicine is on research. Treatments associated with it are few—namely relaxation, biofeedback, and other methods of conditioning behavior. Disorders that most readily lend themselves to the "biobehavioral" approach are those suspected to be related to stress, namely hypertension and heart disease as well as gastrointestinal disorders; circulatory problems, including migraine headaches and Reynaud's disease (in which vasoconstriction causes coldness in the extremities); maladaptive behaviors not susceptible to voluntary control, such as stuttering, bed-wetting, and tics; and chronic pain, which has come to be recognized as a complicated psychophysiological experience rather than a symptom of an underlying physical disorder. Obesity is also an obvious target for the biobehavioral approach representing as it does emotional, behavioral, and physical problems. Although the concept of using feedback to unlearn maladaptive responses adopted by the organism comes to us from behavioral psychology, behavioral medicine seeks to explain the mechanisms by which it works and to incorporate it into a larger, shall we say holistic, context.

This endeavor is clearly manifested in the preoccupation of many researchers with "coronary-prone behavior" and discussion about the merits of the "type A" personality construct that may be helpful in predicting heart attacks. Type A is the hard-driving personality, achievement-oriented, impatient, time-conscious, competitive, and prone to exhibitions of hostility. Researchers have found such a personality to be as predictive of coronary trouble as the other big three indicators—smoking, serum cholesterol, and hypertension—but they want to establish with greater refinement just what aspects of type A behavior are most closely linked with heart attacks and to locate the particular behaviors that can be demonstrably linked to physical precipitators of heart disease.

Hypertension is also a favorite topic of the behavioral medicine set. It seems like a fairly simple phenomenon, as it is determined by only three factors: blood flow, blood volume, and constriction of blood vessels. It is influenced by a multitude of factors, but no one knows what causes essential hypertension. The mysteries of the disorder mean that researchers, although they can breed strains of hypertensive mice, find it very difficult to develop an animal model of *induced* hypertension.

The disorder also presents a clinical challenge cut out for behavioral medicine. Drugs are effective but designed for short-term use. Benign methods such as yoga and biofeedback have not proven terribly effective. There are serious compliance problems for both therapies. But according to Weiss, the biobehavioral treatment solution—start people on drugs, then wean them to a relaxation exercise for maintenance—seems to be effective, judging from the results of small preliminary studies. The drugs and relaxation seem to potentiate each other, and people are much more highly motivated to follow the relaxation regimen in order to escape the unpleasant side effects of the drugs (a form of aversive conditioning). Finally, the program seems to be an effective way to inculcate patients with a fundamental tenet of behavioral medicine, which is that the patient is responsible for his own well-being and must be an active participant in his treatment.

It may be that the development of more new treatment approaches will depend on a more sophisticated understanding of stress. Physical stress is fairly easy to define, but psychological stress is manifested physiologically in different ways depending on the stressor and how the individual copes with it. A widely accepted definition of stress has been supplied by David Glass of the graduate college of City University of New York who calls it "the perception of threat to physical or psychological well-being and the perception that [the individual's] responses are inadequate to cope with it." Physiologically, stress is manifested in various ways, through muscle tension, heart rate, skin response, blood pressure, respiration, and the release of catecholamines (epinephrine and norepinephrine) and cortisol, hormones from the adrenal glands. But paradoxical reactions are so common that one researcher has described the situation as so complex as to be hardly more predictable than random events. For example, among small children who were disturbed at being separated from their mothers on the first day of school, one group showed raised levels of cortisol, while another group showed depressed levels. Other studies have shown that in some instances fear will produce tachycardia (speeded heartbeat) and at other times bradycardia (as when the heart "stands still" with fear).

. . . locating specific neurochemical mechanisms by which subjective states lead to disease.

Stress has also shown paradoxical effects on cancerous growths in animals. Vernon Riley of Pacific Northwest Research Institute has shown that mice subjected to stress—by having their cages rotated or being injected with stress-associated chemicals—were less able to inhibit growth of transplanted tumors. On the other hand, Benjamin Newberry of Kent State University has

found that stress resulted in the inhibition of growth of mouse mammary tumors.

Paradox, as Weiss notes, is really an indicator of another level of complexity. Such experiments demonstrate that the pathways linking psychological or behavioral factors to disease states are far more tortuous, branch in many more ways, and are influenced by far more factors than had been previously imagined.

Researchers are now trying to map some of the connections that have been observed for centuries but never understood. Saul Schanberg of Duke University, for example, has nailed down a chemical indicator of "maternal deprivation syndrome," the phenomenon of stunted physical and emotional development in babies deprived of handling. He has located a particular fast-action enzyme (ODC or ornithine decarboxylase) involved in growth, development, and differentiation, which varied widely in infant mice depending on how much time they were deprived of their mothers.

Behavioral medicine has tackled only a limited assortment of disorders so far. It ultimately could affect treatment of any disease, however, including those whose causes are clearly external (such as bacterial diseases), because it takes into account the wealth of factors that influence an organisms's susceptibility, ability to fight, and ability to respond to medication.—CONSTANCE HOLDEN

Health Committee Investigates Farm Drugs

Proposed legislation would enable FDA to ban the use of antibiotics in animal feeds

Although pigs are at center stage in this controversy, the National Pork Producers Council decided not to speak at hearings on the farm use of antibiotics held 12 and 24 June by Representatives Henry Waxman (D-Calif.) and John Dingell (D-Mich.). The congressmen were laying out the case for their bill (H.R. 7285), which would give the Food and Drug Administration (FDA) more power to carry out its intention of banning the use of penicillin and tetracycline as feed additives. The FDA has been blocked for 2 years now in this campaign by agricultural committees in Congress. They have insisted that the question needs more study, not action (see *Science*, 25 April). Dingell and Waxman are trying to break the logjam.

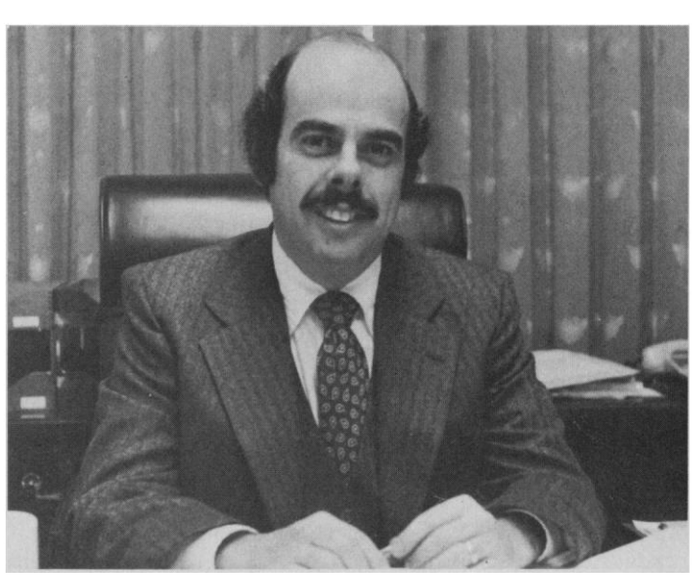
"We're dealing with raggedy science," said Dingell's aide, who explained that Dingell decided to push for new legislation because he thinks the experts are not likely to resolve the issue soon. A panel at the National Academy of Sciences concluded this spring that for technical reasons is may be impossible to prove what many people suspect—that using antibiotics in the barnyard helps create drug-resistant bacteria which will infect humans.

The Pork Council stayed away from the hearings, according to a letter from its president, "mainly because we do not consider it to be a good use of our time or [of that of] the members on the subcommittee"—Waxman's health and environment subcommittee of the House Interstate and Foreign Commerce Committee. The pork people may not have liked the idea that their farm issue was being turned into a health issue. They declared it a boring scene, and kept their distance.

An aide to Dingell speculated that the Pork Council really stayed away out of embarrassment. Its chief lobbyist and regular Washington spokesman, C. D. Van Houweling, retired 2 years ago from the directorship of the bureau of veterinary medicine at the FDA. This office is directly responsible for animal drug policy, and it is being pressured mightily by the drug and meat producers to say that it is all right to mix penicillin and tetracycline in feeds as a growth promoter.

Van Houweling left office before the new bureaucrats' ethics code went into effect, and so he is not prevented from engaging in what the new code would call a conflict of interest. A year from the day of his retirement, he was free to lobby Congress and his old colleagues to see things the way the pork producers do. According to his own interpretation, however, he was free to act as he pleased on the "generic issue" involving antibiotics "the day after I walked out of the office." Yet it may still prove a bit hard for him to execute this change of roles with grace.

Van Houweling's situation contrasts, incidentally, with that of his successor, Lester Crawford. The latter will retire on 1 August to return to the faculty of the University of Georgia. Crawford told *Science* that the reformed ethics code, which does affect him, will mean that



Representative Henry A. Waxman, chairman of the House health subcommittee, supports the FDA's attempt to curtail the use of penicillin and tetracycline in feeds.

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