

COMMENT ON PSYCHOLOGICAL STRESS WORKSHOP
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I appreciate the opportunity to submit the following reflections on the issues addressed at the recent workshop on psychological stress, held under the auspices of the MITRE Corporation, February 4 and 5, 1982.

Feasibility of prediction: General. The underlying problem was the need of the Nuclear Regulatory Commission to frame an appropriate response to the court order calling upon the NRC to decide whether or not to order a full-scale environmental impact statement for the restart of TMI-1 on the grounds of its possible adverse impact upon the psychological health and community well-being of people living in the affected region. Such a statement, like many another technology assessment, is predictive in character, being an attempt to figure on the basis of scientific data and theory what is likely to be the consequence of a contemplated technological move. In this case, there is the novel feature that the consequences are psychological, psychiatric, and sociological in nature, and the data and theories involved are almost exclusively those of the behavioral and medical sciences.

The first question that must be addressed, therefore, is the basic one: Is prediction possible in psychology? And if so, is it good enough to justify the cost of the requisite research? An unequivocally positive answer can be given: The actual record of predictions in the behavioral sciences is quite respectable, particularly when one recalls that prediction is difficult and imprecise in any science once we get outside the doors of the laboratory and try to say what will happen under real-life conditions. Even meteorologists occasionally stumble, despite their statistically excellent track record and the fact that they are dealing with an application of the most thoroughly established physical sciences. The behavioral sciences can point to a number of rather distinguished successes

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in a variety of realms.² We can predict to a useful degree by a cost-benefit criterion such diverse behavior as voting in political elections (with a probable error of about 2%), academic grades in college, the likelihood that prisoners will violate parole, and the economic behavior of consumers--their decisions to spend or save. That does not guarantee that every behavioral scientist will do a creditable job in attempts to predict any behavior. but it does at least serve to dismiss the claim by some ignorant or cynical critics that human behavior is intrinsically unpredictable.

Furthermore, the nature of the alternative must be borne in mind--the certainty that if no attempt is made to collect and process data in a scientific manner, the decision will be made anyway without the benefit of the most relevant facts and theories. Under such circumstances, decisions are likely to be influenced by political pressures and other extrinsic considerations, despite all the good will in the world on the part of the decision makers. Moreover, the conclusions of an environmental impact study could at most have advisory and not definitive influence. Granted the importance of the present issue, the conclusion seems inescapable that the decision should be made with scientific guidance and a maximum of relevant information.

Feasibility of a prediction study: Specific. It would be possible to do a meaningful and useful predictive impact study, for the following reasons. First, there was substantial consensus at the workshop that chronic psychological stress has produced a small but measurable and deleterious chronic impact upon psychological health in the Three Mile Island area. Second, it is possible to explain and understand those effects by means of a coherent psychological theory, which

2. I have reviewed relevant studies in my book Methods in clinical psychology. Vol. 2: Prediction and research. New York: Plenum, 1978. Much of the theoretical section below is based upon work done for my chapter, "Occupational stress," in L. Goldberger & S. Breznitz (eds.), Handbook of stress, New York: Macmillan Free Press, in press.

provides the specifications for a set of data needed to make predictions about further such effects that would be caused by restart. Third, the needed data do not presently exist, but can be obtained quite feasibly and not too expensively. The remainder of this communication will be devoted to sketching the theory, the design of a feasible study, and supporting details. I omit a summary of the available evidence in support of the first numbered assertion in this paragraph, because I believe that it is already available to MITRE and to the NRC staff.

Theory of effects of radiological stress on psychological health. No claim is being made that ionizing radiation itself has a direct impact upon psychological health, and no denial that effects could exist, either. The rationale to be presented does not depend upon the actual irradiation of anyone, only the threat thereof.

A theoretical understanding of the impairment of health from such causes as we are dealing with here may be expressed via the following schematic flow charts. First, consider a normal, healthy state of affairs when a person is confronted by danger (Fig. 1). The diagram says that perceived danger arouses a physiological alarm system, which sustains adaptive efforts, which lead to successful coping, which cause an increase in the sense of adequacy and effectiveness; the perception of success inhibits the adaptive efforts (no longer necessary), and the increased sense of adequacy helps inhibit physiological alarm. In addition to the indicated effects of successful adaptive efforts, by definition they also take the person out of danger, hence stop the continuous input to the system, which switches off.

Consider now the unsuccessful case (fig. 2). When the adaptive efforts fail (as by encountering a barrier that prevents either escape or successful counter-attack) and the danger persists, input to the alarm system is continuous, and there is a secondary effect through the person's seeing his inability to be effective--he feels inadequate or helpless, which tends to inhibit adaptive ef-

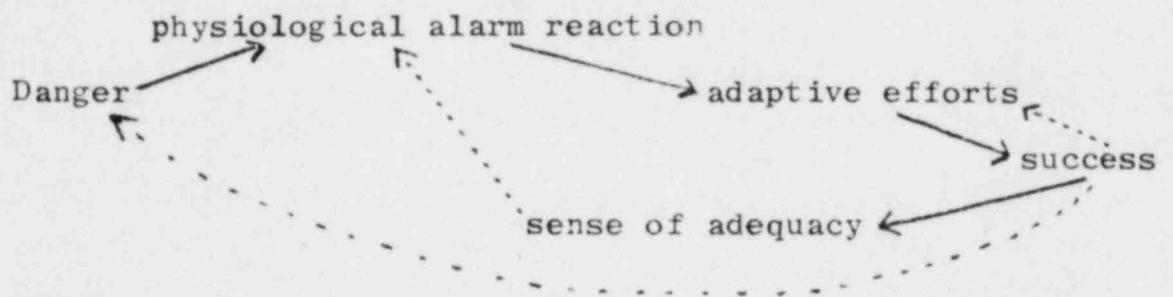


Figure 1. Diagram of normal, adaptive response to experienced danger

(Note: In this and the following diagrams, solid lines indicate a stimulative or enhancing effect, dotted lines an inhibitory or switch-off effect.)

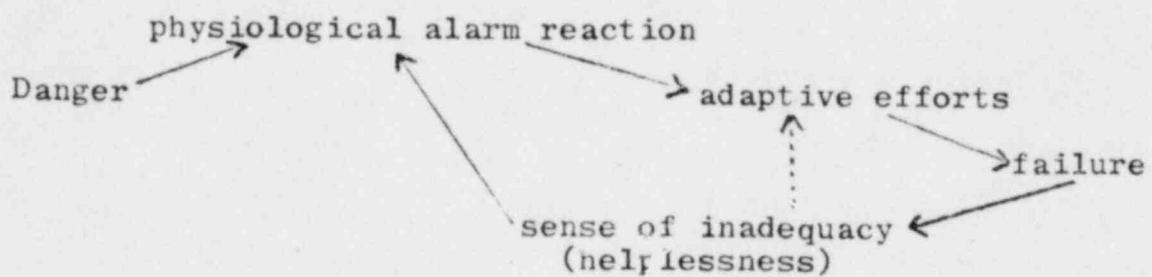


Figure 2. Diagram of unsuccessful response to experienced danger

forts and to have a multiplier effect on physiological alarm (positive feedback loop). That then brings into play the pathological system diagrammed in Fig. 3.

Fig. 3 tells us that when physiological alarm reactions become chronic, from continuous instigating inputs (Fig.2), they produce a set of what are known as physiological strains (e.g., hypersecretion of various endocrine glands and of the stomach, hypertension, overreaction of the reticular activating system, release of histamine, etc.), which produce such stress symptoms (of Selye's General Adaptation Syndrome) as tremulousness, gastritis, headaches, insomnia, hives, etc. These symptoms in turn interfere with normal adaptive behavior. Meanwhile, the chronic sense of helplessness and inadequacy produces--in interaction with some of the physiological strains--a set of psychological symptoms including anxiety, depression, and anomie (alienation, loss of morale), which also interfere with normal adaptive behavior. Unable to cope effectively with his problems, the person feels even more inadequate and helpless. This positive feedback loop from impaired adaptiveness to the sense of helplessness and back again constitutes a "vicious circle" that tends to amplify the effect of the chronic alarm state, so that the condition has a tendency to become worse. (At the same time, a number of counterbalancing factors tend to diminish the pathogenicity of the vicious circle, notably a belief that the danger is diminishing.) Note also the indication that the sense of helplessness makes some contribution to stress symptoms and directly interferes with adaptive coping efforts. If other stresses are present, they also contribute to the physiological strains.

The region near the right side of Fig. 3 indicated by dashed vertical lines indicates a set of moderating variables,³ some of which ("weakeners") serve to exacerbate, others ("strengtheners") to ameliorate or counteract the pathogenic

3. In the interests of keeping the diagram relatively simple, I have omitted a good many other moderating variables that have been postulated (notably, defenses, coping devices or strategies, and cognitive styles). There is evidence that some of them are important in determining the "choice of illness" or symptom specificity, which I am neglecting here.

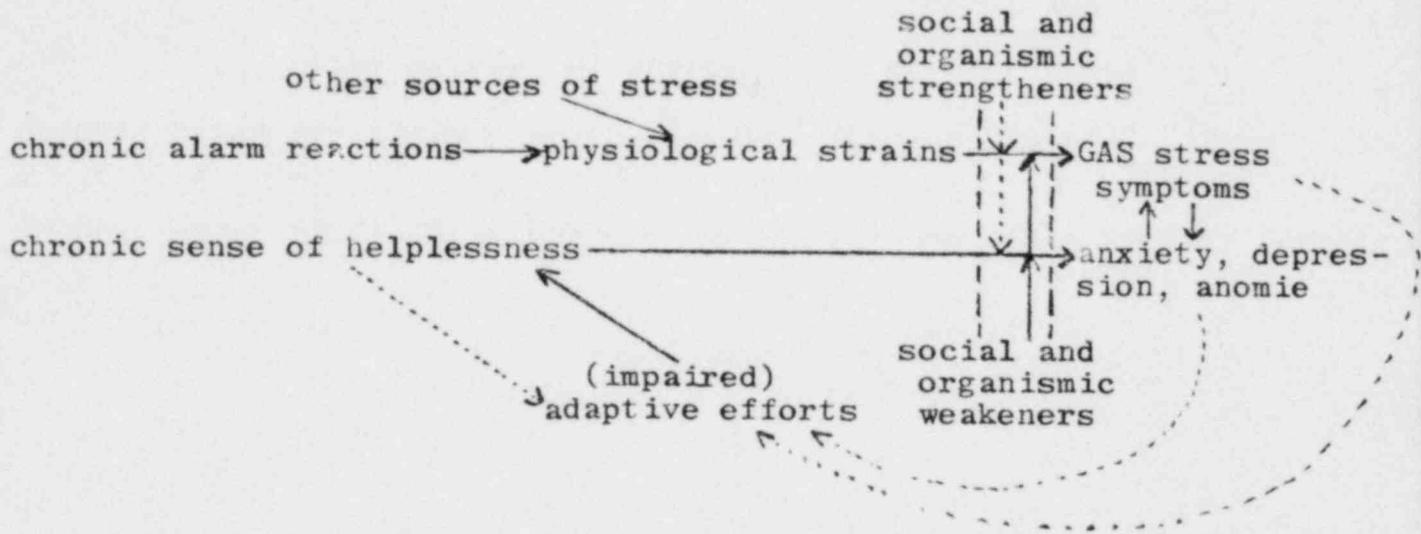


Figure 3. Diagram of chronic impairment of health

process. More is known about weakeners than strengtheners; the former include physiological conditions and developmental stages (e.g., physical illness, malnutrition, mental deficiency, pregnancy, infancy and childhood, menopause, old age) and sociopsychological states (e.g., unemployment, poverty, institutionalization, marital friction, vocational dissatisfaction). A special subclass is prior exposure to the same danger (e.g., people who evacuated at the time of the accident and/or the krypton venting). The principal strengthener identified in stressresearch is social support networks: the more a person feels sustained and supported by family, friends, helpful coworkers and supervisors, the more resiliently he tends to respond to otherwise stressful conditions. A further important variable, the degree to which the person trusts and believes experts and authorities (sources of information concerning the danger), can be conceived as operating as one of these moderating variables.

A useful way to look upon the moderator variables is that the list of weakeners constitutes a set of hypotheses about subpopulations at risk--those who may be expected, in light of available research evidence, to be most susceptible to stress and other deleterious effects of a given environmental impact (such as the proposed restart of TMI-1). Retrospective or secondary analysis of data from such studies as those of Houts, Bromet, Kasl, Vyner, and Goldstein should be used to test some of these hypotheses and to identify other groups at risk to develop adverse health impacts from reactor-induced threat.

At this point, the above theory may be restated in the form of a general and a specific proposition.

1. People who feel chronically endangered and helpless to avoid peril eventually suffer adverse effects upon their health,⁴ expressed in an increase

4. Though two classes of symptoms are distinguished here, I do not try to subdivide the concept of health, which is by definition a characterization of the whole person. A person suffering from largely physiological stress symptoms can hardly be said to be in a good state of psychological health. It is also not meaningful to try to classify certain symptoms (e.g., nausea, insomnia) as either psychological or physiological: they are organismic.

in both psychological (mental, emotional) and physiological (physical, bodily) symptoms, which will be especially severe in identifiable groups at risk.

2. Such a pathogenic state will come about in persons in the vicinity of an operating nuclear plant, if these persons believe that they are endangered by the nuclear plant and if they feel helpless to take effective action to increase their safety.

Note that in statement 2, "vicinity" must be subjectively defined: a person is in the vicinity if s/he believes that s/he is close enough to be harmed, either by routine operations or by an accident. Evacuation studies showed that some persons 50 or more miles from TMI felt themselves enough endangered by the accident to leave their homes and travel considerable distances for several days to escape; hence, adopting an arbitrary though convenient physical definition of "vicinity" will result in underestimating deleterious impacts of a restart upon health.

Note also that the fear (feeling of endangerment) may be to various degrees rational, based upon a correct understanding of the nature of ionizing radiation and its biological effects and of the structure and functioning of nuclear power plants, or irrational and ill-informed; that is largely irrelevant. Educational efforts would alleviate the irrational components, to the extent that they were credible, but valid information about the nature of ionizing radiation and its biological effects or about the actual structure and functioning of TMI-1 and the range of accidents that are possible there would probably increase fear even though it was presented as part of an effort at amelioration, counter to the beliefs and hopes of the industry.⁵ As Slovic and his colleagues have demonstrated, nuclear power is considered an especially dread source of danger because of its unusual characteristics: Ionizing radiation is imperceptible, hence the citizen

5. And invalid information would cause a further increase in distrust, seriously undermining the effectiveness of emergency measures should they be needed.

is dependent upon experts and authorities for all relevant information, and because of their past performance (especially during and after the 1979 accident) s/he often distrusts official reassurances; and nuclear plants can have catastrophic accidents, with disastrous consequences. The public is much less reassured than are those who work for the utility or the NRC by figures on the low probability of such accidents; indeed, the public believes that less is known about the dangers of nuclear power and with less certainty than experts claim.

A final comment on the above theory: It is intended to account for chronic impairment of health, not acute reactions such as those to the 1979 accident, or the venting of krypton. If there were a restart of TMI-1, one might expect a transient anticipatory flare-up of anxiety, norepinephrine secretion, and other such effects as those reported by Baum et al. in their venting study; but I am neglecting such effects here. Likewise, I consider of negligible importance the possibility of a phobic reaction focussed on the event of restart itself, which seems to have engaged so much of Dr. Dupont's attention. As to the possibly stressful effects of a decision not to restart, it seems safe to assume that they would be confined to a very small group of workers who would lose their jobs; my expectation is that stockholders would experience stress primarily to their portfolios.

What I have described as a theory here could also be viewed as a series of testable hypotheses, which can and should be tested. To the extent that it is valid, the theory can then be used to predict the effect of the restart, using freshly gathered data.

Needed research. What we need, therefore, is a two-tier or dual study: first, the basic hypotheses of the theory need to be tested; in part, that can be done by means of a secondary analysis of existing data, but in part it will require the gathering of data to test the postulated relationship between chronic health effects and certain beliefs about which no investigators have reported inquiring, in any research I have read. Second, in order to predict the impact of a restart on psychological health, it will be necessary to obtain new, up-to-date data in the entire affected region.

The basic kind of data needed from reanalyses of existing data bases is simple and straightforward: cross-tabulation of all items of belief and attitude against measures of health effects, to yield incidence rates for symptoms by groups of people holding different beliefs. Thus, for example, suppose an investigator asked, "How dangerous do you feel that TMI is to you today-- extremely dangerous, dangerous, slightly dangerous, not dangerous at all?" In the same survey, assume that people were also asked how often they had headaches: often, occasionally, or never. The cross-tabulation should be reported in a table of four columns (degrees of danger) and three rows (frequency of headaches), so that one can compare percentages of people reporting many, few, or no headaches among those who admit to various degrees of endangerment. Such cross-tabulations should be done for homogeneous groups separately, whenever they are large enough. (E.g., as Bromet analyzed in this way the data for mothers and for plant workers.) In order to minimize the likelihood of contaminating the chronic with acute effects, these analyses should be done only with data taken at least six months after the accident (i.e., from mid-October 1979 to date).

The basic method of prediction would be, then, ^{to} follow this model: Suppose that in a certain sector of the population 15% of those who reported that TMI was "extremely dangerous" reported having headaches "often." The predictive study would ask a new sample of that same subpopulation, "How dangerous do you

feel TMI would be to you if unit 1 is restarted--extremely dangerous...not dangerous at all?" For those who replied, "extremely dangerous," the prediction would be that 15% of them would develop frequent headaches. From a knowledge of sampling rates and the size of the target population, it would be possible to assemble a final total prediction of the number of persons who would develop chronic impairment of psychological health.

There are of course many more details to be worked out for the concrete planning of the project. I trust, however, that the above is enough to indicate (a) that the proposed predictive method is logical and feasible, (b) that no such study has been done to date, and (c) that some use could be made of existing data, but that further data are indispensable. Note also that if TMI-1 is in fact restarted, the design makes it simple to collect the data needed to validate the predictions. (Under those conditions, it would be useful to have a control group from an area where people do not consider themselves endangered by TMI. It is rather striking that in the venting research by Baum et al., appreciable numbers of people in the control community of Frederick, MD did report feeling threatened by TMI, thereby not constituting as sensitive a control group as would have been desirable.)

For the predictive study, the respondents should consist of a basic probability sample drawn from the area 5 miles or less from the plant, 5 to 10 miles, 10 to 15, 15 to 20, 20 to 25, and 40 to 55 miles from the plant, sampling at lower rates in each larger ring. This general sample should be supplemented by special samples of at-risk subgroups: e.g., pregnant women and mothers of infants and toddlers, unemployed breadwinners, poor minority group members, et al. A control group from a distant but demographically comparable area would be highly desirable but not necessary.

Questions to be asked⁶ should first gather basic data concerning respondents' (Rs') information and beliefs concerning TMI-1 and nuclear power. Those who are unaware of the plant cannot feel threatened by it; likewise those who know of no dangers posed by nuclear plants. The nature and extent of any threat or danger R believes that TMI-1 would entail to himself or to those he loves or is responsible for if restarted; beliefs about the effects of ionizing radiation upon health and one's progeny; beliefs about past exposure to radiation and degree of damage thereby; beliefs concerning the detectability of ionizing radiation by the senses, and how one does ascertain that one is or may be exposed to appreciable doses, what to do about it, and when the danger is over; beliefs about the persons who have the technical knowledge and instruments to monitor radiological danger and persons who transmit such information to the public, their motivation (are they seen as disinterested or biased by the profit motive?), their competence, and their credibility; beliefs about the amount and dangerousness of radiation (or radionuclides) emitted in "routine operations"; beliefs about possible accidents--how serious they might be, and how likely, and how far R's apprehension about consequences is mitigated by knowledge of their (low) probability; knowledge of and beliefs about emergency planning and readiness, including R's own plans if any about what to do in case of another serious accident; beliefs about other ways and the total degree to which R could protect self and others about whom he cares; beliefs concerning any other harms, and concerning all benefits, to be expected from restart; beliefs concerning dangers or bad consequences of not restarting; R's overall feeling about the desirability of restart. With respect to many above questions, it would be desirable to ascertain the degree of uncertainty R feels about the answer.

6. The proposed secondary analysis of existing data bases would be very helpful to the framing of questions. To some extent, alternative ways of wording similar inquiries may show different ability to predict symptoms.

To ascertain R's possible membership in at-risk groups, questions concerning various demographic variables (e.g., occupation, employment, age, marital status, number of dependents or persons for whom R feels personally responsible), state of health--general, and degree to which R currently experiences stress symptoms (those assessed by Houts, by Bromet, and by the demoralization scale), history of past hospitalizations and serious illnesses, general level of life satisfaction, Rahe life-event score and other recent stressful experiences, general level of alienation vs. trust and faith in basic institutions. What did R do and experience at time of TMI-2 accident and Kr venting--evacuate? How does R feel now about own response at those times? What has R done on other occasions to indicate degree of concern about possible adverse effects of radiation? What is the nature and extent of R's social support network? What is R's general level of self-esteem and feeling of competence vs. helplessness?

The necessary data could be gathered by an independent survey research organization (I would recommend Yankelovich, Skelly, & White, Inc., of New York City, which has the capability to do in-depth interviewing anywhere in the country, and all of the other needed technical resources--e.g., drawing the sample).

Since the two-stage predictive study outlined is quite feasible at reasonable cost, and could be completed within a few months, and since it would greatly enhance the NRC's ability to estimate the probable environmental impact of restart, I strongly urge that such a project be undertaken. I would be glad to consult with its directors or to supply backup data, references, etc., supporting various statements made here.