37. Psychological Job Stress

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The concept of psychological job stress has received widespread interest from both the scientific community and the public. This is understandable in light of its intuitive appeal and applicability to a wide variety of medical, psychological, and sociological concerns. Such attention often operates as a two-edged sword, however, for while public support for a research program is always appreciated, there is a very real risk that the resulting popularism and overexposure will dilute the scientific credibility of the concept itself. That this has not yet happened to "stress" attests to its usefulness and validity as a theoretical construct, and to the growing body of evidence linking distressful antecedent experiences to impaired psychological and physiological functioning.

To a considerable extent, much of the current impetus for stress research can be traced to the seminal work of Hans Selye [54–56] and his description of the general adaptative syndrome (GAS). Following exposure to any of a variety of physical, chemical, and biological insults, Selye noted, rats developed a predictable response syndrome consisting of enlargement of the adrenal glands, involution of the thymus and related lymphatic structure, and ulceration of the lining of the stomach wall. These effects were nonspecific in that they occurred regardless of the nature of the insult and were superimposed upon any specific effects associated with the individual stressors. Selye described the subjective or psychological concomitants of this reaction as involving a feeling of general malaise or lethargy, and noted that stress-related symptoms appeared during the final stage of a triphasic effort by the organism to cope with the environmental challenge.

THE STAGES OF STRESS RESPONSE

ALARM STAGE

The first and immediate reaction to a perceived stress Selye termed the alarm stage, involving an awareness and recognition of a potential threat, with consequent activation of the sympathetic nervous system (e.g., increased heart rate, blood pressure, muscular tension, and adrenal discharge) resulting in an overall state of heightened arousal and readiness to respond.

RESISTANCE STAGE

Alarm is followed by the resistance stage, during which the individual engages in specific psychological, physiological, and behavioral efforts to

cope with the perceived source of stress and to return the body to its previous level of physical and psychological functioning.

EXHAUSTION STAGE

Finally, if attempts to cope prove unsuccessful, the individual eventually depletes all psychological and physical reserves and enters the exhaustion stage, during which time resistance is low and vulnerability to psychological and physical disorders is high. In this respect, *stress* is a generic term for any stimulus, event, or condition that disrupts the homeostatic functioning of the individual's psychological and physiological systems, thereby initiating adaptative or restorative activities.

Although much of Selye's investigation was focused on *physical* stressors (e.g., noise, temperature extremes, radiation) in GAS development, subsequent work indicates that psychological stressors produce similar effects [20, 42, 62]. In fact, according to Mason [45], psychological factors (e.g., threat, uncertainty, novelty, fear) are among the most potent natural stimuli influencing the pituitary-adrenal-cortical system, and mediation by psychological factors may be a necessary step in triggering endocrine responses to physical agents. Mason cites, for example, research indicating that the corticosteroid response of an animal is often greater during the anticipation period before presentation of an aversive conditioned stimulus than it is to the stimulus itself—his conclusion being that activation of the pituitary-adrenal-cortical system is more pronounced under conditions producing general or undifferentiated arousal. Implied here is a homeostatic model of human beings that assumes that the individual strives to function within an optimal range of psychological and physiological arousal. Deviations from that baseline, arising from too much or too little stimulation (regardless of the source of stimulation), are experienced as stressful and trigger off a set of sympathetic nervous system and psychoendocrine responses aimed at eliminating stress and restoring the body to its customary level of functioning [11, 18, 30].

If the individual is unable to regulate the level of arousal either by manipulating the external environment or by engaging in some form of perceptual reappraisal or cognitive restructuring aimed at redefining the experience as less stressful [46], psychological and physical exhaustion may occur, with potential pathogenic consequences. Coronary heart disease [26, 28, 33], diabetes [40, 57], hypertension [13, 50, 53], ulcers [16, 22], rheumatoid arthritis [8, 40], and a variety of other disorders [42, 62] have been related to psychogenic factors. In such cases the appearance of illness presumably reflects depletion of the individual's abilities to cope with an experienced stress and signifies discord between perceived environmental demands and individual adaptive capacities. This suggests that our understanding of stress-related disorders must involve at least three levels of analysis.

Psychological Processes. The first level involves the personality characteristics of the individual that influence his or her perception and interpretation of life events (either experienced or anticipated) and feelings of being able to cope with them. Research indicates, for example, a relationship between cardiovascular disease and a behavioral style characterized by time urgency, competitiveness, and latent hostility ("type A" personality) [26, 28]. LeShan [41] and others [19, 52] have assembled evidence linking cancer mortality to premorbid coping styles characterized by passivity and learned helplessness. Shapiro [58] has described the obsessive-compulsive personality as particularly prone to worry and anxiety, with consequent adverse effects on general health and functioning. On the positive side of personality influences, self-esteem and social belongingness have been shown to moderate the effects of stress, buffering the individual against adverse life experiences [6].

Coping Strategies. The second level of analysis pertains to the range and effectiveness of coping strategies that the individual possesses to combat experienced stress. The most effective means of controlling stress arising from objective physical and psychosocial conditions is to act directly on the source of the stress to effect desired change. In those situations where the individual has little control or power over the source of stress, alternative means of coping become necessary. Muscle relaxation [4], biofeedback [59], transcendental meditation [48], and social support [6] are all means of minimizing the deleterious impact of inescapable or unavoidable stress on the individual's health and well-being. Obviously, the more coping tools and strategies at one's disposal, the better able one is to deal with experienced stress.

Work Stressors. Finally, we must consider those psychosocial events and conditions that are potentially pathogenic to the majority of people who experience them. Although social and cultural

change [14, 29], crowding [43], and uncertainty [3] are among the general life stressors identified as contributing to morbidity, researchers are increasingly calling attention to the work arena as a primary source of stress for the individual.

In general, three global features of the work environment command attention: organizational structure and climate; role demands and expectations; and job and task requirements.

Organizational Structure and Climate. While many aspects of the structure and climate of an organization can be viewed as potentially stressful, relatively few have been subjected to research scrutiny. Of those aspects that have been examined, the greatest emphasis has been devoted to lack of participation in decision making. Research on participation was undertaken initially in terms of the effects of work on workers' attitudes and productivity. Several field studies conducted by French [10, 24] demonstrated that greater participation in the decision-making process leads to greater job satisfaction, lower turnover, better supervisor-subordinate relationships, and increased productivity. Since those early studies, other beneficial effects of participation have been noted. French and Caplan [22], in a study conducted at Goddard Space Flight Center, found that people who participated at work reported high levels of self-esteem—and, in comparison to low participators, perceived greater opportunities for advancement. Margolis, Kroes, and Quinn [44], in a nationally representative sample of nearly 1500 workers, found that nonparticipation at work was significantly related not only to low self-esteem and low job satisfaction but to overall poor physical health, escapist drinking, depressed mood, and absenteeism.

Another organizational climate characteristic shown to have health consequences is uncertainty regarding the future (i.e., lack of job security or fear of redundancy, obsolescence, or forced early retirement). Margolis et al. [44] found that uncertainty about continued employment was related to low job satisfaction, low life satisfaction, low self-esteem, escapist drinking, and overall poor physical health. Similarly, Cobb and Kasl [7] in a longitudinal investigation of the health and behavioral effects of job loss found an increased incidence of complaints of poor health among men notified of impending job loss. Moreover, there was a suggestion of increased frequency of peptic ulcer both in those men and in their wives as they experienced the uncertainty associated with job loss and eventual unemployment.

Role Demands and Expectations. In contrast to the limited attention devoted in stress research to organizational structure and climate factors, numerous studies have examined the stress associated with job incumbents' work role. These investigations were given original impetus by a study of role ambiguity and role conflict conducted in the early 1960s by Robert Kahn and his colleagues [36]. Surveying a national sample, Kahn et al. found that men who suffer from role ambiguity (i.e., lack of clarity about objectives associated with the work role, about colleagues' expectations concerning the work role, and about the scope and responsibilities of the job) experienced low self-confidence, high job-related tension, intense futility, and minimal job satisfaction. As might be expected, workers who experienced role ambiguity (i.e., conflicting job demands) were found to experience job-related tension and to report low job satisfaction. Role ambiguity has been linked to various other indicators of poor mental health, including depressed mood, dissatisfaction with life, and decreased motivation to work [44], and to physiological strains such as increased heart rate and increased blood pressure [22]. Role conflict has similarly been related to increased heart rate [22] and to abnormal electrocardiographic readings indicative of coronary heart disease [60].

Responsibility for the lives and well-being of others is still another role demand that has been associated with deleterious consequences. Evidence for this association comes from a variety of sources. Early epidemiologic studies showed that physicians, who obviously bear a great deal of responsibility for others, have an excess of ulcers [1, 15] and of myocardial infarctions. Similarly, foremen were observed to have an excess of peptic ulcer [15]. More recently, Cobb and Rose [9], in a large-scale study of medical records of air traffic controllers and commercial pilots, found that controllers had high rates of high blood pressure and peptic ulcer. Moreover, controllers at high-density airports were found to have higher disease rates than controllers at low-density airports. Further, French and Caplan [23] in a study of NASA professionals have linked responsibility for people to an increased frequency of cigarette smoking.

Job and Task Requirements. Job demands and task characteristics were an early and vital focus for job stress researchers and, unlike aspects of organizational structure and climate and role demand and expectation considerations, have remained a preoccupation. Among the elements of the work environment examined under this rubric have been features of workload and work pacing.

Workload. This feature of occupations is one that is intuitively recognized as stress-producing. As a consequence, it has received substantial empirical attention. Two varieties of workload have been distinguished: quantitative and qualitative [23]. *Quantitative workload* can be either "too much to do" (quantitative overload) or "too little to do" (quantitative underload). Moreover, there are two types of qualitative workload: qualitative overload, or work that is too difficult to do, and qualitative underload, or work that is too easy to do.

Quantitative overload, in combination with other job pressures, has long been thought to play a role in the development of coronary heart disease (CHD). For example, working excessive hours or holding down more than one job (or both) has been associated with CHD morbidity and mortality [32, 34]. Studies showing a correlation between quantitative workload and serum cholesterol levels [23, 27, 51] also seem to support the hypothesis of an overload-CHD association.

Like quantitative overload, qualitative overload has been shown to have adverse psychological and physical consequences. In an early study of stress among college professors at a large university [25], qualitative overload was found to be positively related to job tension and inversely related to self-esteem. Similar findings with respect to self-esteem were also evident in a study of scientists at Goddard Space Flight Center [23]. Other studies have reported an association between qualitative overload and serum cholesterol [27] and serum uric acid [5] levels suggesting a possible link to CHD.

In comparison to quantitative and qualitative overload, quantitative and qualitative underload has received much less research attention. Nevertheless, it too seems to represent a threat to health. Monotonous work, for example, has been associated with job dissatisfaction, poor mental health, CHD, peptic ulcers, and gastritis [12, 49].

Work Pacing. Almost from the inception of research, machine-paced work has been implicated in syndromes of health disorders. Early field studies reported a variety of negative psychological reactions in workers involved in machine-paced jobs. These reactions included expressions of high job dissatisfaction [64], tension [39], and feelings of anonymity [61] and underuse of abilities [38]. Other studies have reported more frequent health complaints among workers in machine-paced tasks, such as muscle cramps and spasms, nervous disorders [37], and such psychosomatic problems as peptic ulcers, heart attacks, and strokes [21].

In a recent comprehensive study, Frankenhauser and Gardell [21] studied machine-paced and self-paced workers in Swedish sawmill operations, using questionnaires, health examinations, and clinical laboratory tests. They found complaints of monotony, general mental strain, and exhaustion at the end of the work day, as well as frequent sick leave requests and morbidity, more among workers in machine-paced jobs than among those in self-paced jobs. Medical examinations revealed a higher incidence of psychosomatic, cardiovascular, and stress disorders among workers involved in the machine-paced tasks than among those in nonpaced jobs. Results of biomedical tests indicated elevated adrenaline secretion in workers involved in paced job operations and a similar, though nonsignificant, trend for noradrenaline release.

Frankenhauser and Gardell [21] related the biomedical findings to both self-reported feelings of "well-being" and measures of job repetitiousness. Specifically, low adrenaline release was associated with positive statements of well-being and slight job repetitiousness. Among machine-paced workers, feelings of exhaustion at the end of the shift and inability to relax soon after work were related to increased adrenaline secretion. These authors concluded that lack of control over work was an important contributing factor in producing increased "wear and tear" among workers engaged in machine-paced jobs.

A number of laboratory studies have also suggested that paced work may be deleterious. Ettema and Nielhuis [17] reported elevations in heart rate, blood pressure, and breathing rate with a decrease in sinus arrhythmia (i.e., heart rate variability) as performance requirements on a simple binary-choice task increased from low to high levels. Further, Amaria [2] found higher heart rates under three conditions of forced paced work as compared with heart rate when subjects worked at their own pace. Similarly, Johansson and Lindstrom [35] reported that subject-controlled performance rate on a complex reaction test was judged more favorably and was associated with lower heart rates than a work pace controlled by the experimenter.

CONCLUSION

This review has considered the sources, and the physical and psychological consequences of stress

for the individual. It should be recognized that stress also jeopardizes organizational efficiency. Rapid employee turnover, absenteeism, alcoholism, and drug abuse are only a few of the forms of coping with job stress that pose a serious threat not only to the effectiveness of organizations but to the total national economy. Estimates of annual losses in productivity due to stress-related mental illness alone have been set at $17 billion [65]. We are witnessing a rise in worker compensation claims for both chronic and psychiatric disability. Organizations can no longer afford to ignore job stress. Instead, it has become increasingly mandatory for organizations to understand its nature and causes and endeavor to deal with it.

REFERENCES

1. Alsted, G. Social and public aspect of peptic ulcer. *Gastroenterotology* 26:268, 1954.
2. Amaria, P. J. Effect of Paced and Unpaced Work Situations. In C. H. Gudnason and E. N. Corlett (Eds.), *Development of Production Systems.* London: Taylor & Francis, 1974.
3. Averill, J. R., and Rosenn, M. Vigilant and nonvigilant coping strategies and psychophysiological stress reactions during the anticipation of electric shock. *J. Pers. Soc. Psychol.* 23:128, 1972.
4. Benson, H. *The Relaxation Response.* New York: Morrow, 1975.
5. Brooks, G. W., and Mueller, E. F. Serum urate concentrations among university professors. *J.A.M.A.* 195:415, 1966.
6. Cobb, S. Social support as a moderator of life stress. *Psychosom. Med.* 38:300, 1976.
7. Cobb, S., and Kasl, S. V. *Termination: The Consequences of Job Loss.* U.S. Dept. of Health, Education and Welfare (NIOSH) Publication No. 77-224. Washington, D.C.: U.S. Government Printing Office, 1977.
8. Cobb, S., Kasl, S. V., French, J. R. P., Jr., and Norstabo, C. Intrafamilial transmission at rheumatoid arthritis. Why do wives with rheumatoid arthritis have husbands with peptic ulcers? *J. Chron. Dis.* 22:279, 1969.
9. Cobb, S., and Rose, R. M. Hypertension, peptic ulcer, and diabetes in air traffic controllers. *J.A.M.A.* 224:489, 1973.
10. Coch, L., and French, J. R. P. Overcoming resistance to change. *Human Relations* 11:512, 1948.
11. Cohen, S. Aftereffects of stress on human performance and social behavior: A review of research and theory. *Psychol. Bull.* 88(1):82, 1980.

11a. Colligan, M. J., et al. An investigation of apparent mass psychogenic illness in an electronics plant. *J. Behav. Med.* 2(3):297, 1979.

11b. Colligan, M. J., and Murphy, L. R. Mass psychogenic illness in organizations. *J. O. Psychol.* 52:77, 1979.

11c. Colligan, M. J., Pennebaker, J., and Murphy, L. R. (Eds.). *Mass Psychogenic Illness: A Social Psychological Analysis.* Hillsdale, N.J.: Erlbaum, 1982.

12. Cox, J. Repetitive Work. In C. L. Cooper and R. Payne (Eds.), *Current Concerns in Occupational Stress.* New York: Wiley, 1980.
13. Cruz-Coke, R. Environmental influences and arterial blood pressure. *Lancet* 2:885, 1960.
14. Dohrenwend, B. S., and Dohrenwend, B. P. *Stressful Life Events: Their Nature and Effects.* New York: Wiley, 1974.
15. Doll, R., and Jones, F. A. *Occupational Factors in the Aeteology of Gastric and Duodenal Ulcers* (Medical Research Council Special Report Series). London: Her Majesty's Stationery Office, 1951.
16. Dunn, J. P., and Cobb, S. Frequency of peptic ulcer among executives, craftsmen and foremen. *J.O.M.* 4:343, 1962.
17. Ettema, J. H., and Zielhuis, R. L. Psychological parameters of mental load. *Ergonomics* 14:137, 1971.
18. Fisk, D. W., and Maddi, S. R. *Functions of Varied Experience.* Homewood, Ill.: Dorsey, 1961.
19. Fox, B. H. Premorbid psychological factors as related to cancer incidence. *J. Behav. Med.* 1: 45, 1978.
20. Frankenhauser, M. Experimental Approaches to the Study of Human Behavior as Related to Neuroendocrine Functions. In L. Levi (Ed.), *Society, Stress and Disease* (Vol. 1). London: Oxford Press, 1971.
21. Frankenhauser, M., and Gardell, B. Underload and overload in working life: Outline of a multidisciplinary approach. *J. Human Stress* 2:35, 1976.
22. French, J. R. P., and Caplan, R. D. Psychosocial factors in coronary heart disease. *Ind. Med.* 39: 383, 1970.
23. French, J. R. P., and Caplan, R. D. Organizational Stress and Individual Strain. In A. J. Marrow (Ed.), *The Failure of Success.* New York: AMACOM, 1972.
24. French, J. R. P., Israel, J., and As, D. An experiment in participation in a Norwegian factory. *Human Relations* 13(1):3, 1960.
25. French, J. R. P., Jr., Tupper, C. J., and Mueller, E. F. *Work Load of University Professors.* Cooperative Research Project No. 2171. Ann Arbor, Mich.: University of Michigan, 1965.
26. Friedman, M., and Rosenman, R. H. *Type A Behavior and Your Heart.* New York: Knopf, 1974.
27. Friedman, M. D., Rosenman, R. D., and Carroll,

V. Changes in serum cholesterol and blood clotting time in men subjected to cyclic variation of occupational stress. *Circulation* 17:852, 1958.
28. Glass, D. C. *Behavior Patterns, Stress, and Coronary Disease.* Hillsdale, N.J.: Erlbaum, 1977.
29. Gunderson, E. K. E., and Rahe, R. H. *Life Stress and Illness.* Springfield, Ill.: Thomas, 1974.
30. Hamilton, V., and Warburton, D. M. (Eds.), *Human Stress and Cognition.* New York: Wiley, 1979.
31. Hodges, W. F., and Spielberger, C. D. The effects of threat of shock on heart rate for subjects who differ in manifest anxiety and fear of shock. *Psychophysiology* 2:287, 1966.
32. House, J. S. Occupational stress and coronary heart disease: A review and theoretical integration. *J. Health Soc. Behav.* 15:12, 1974.
33. House, J. S. Occupational stress as a precursor to coronary disease. In W. D. Gentry and R. B. Williams, Jr. (Eds.), *Psychological Aspects of Myocardial Infarction and Coronary Care.* St. Louis: Mosby, 1975.
34. Jenkins, C. D. P. Psychologic and social precursors of coronary disease, *N. Engl. J. Med.* 284:244, 1971.
35. Johansson, G., and Lindstrom, B. *Paced and Unpaced Work under Salary and Piece-Rate Conditions.* Report #359 from the Department of Psychology. Stockholm, Sweden: University of Stockholm, 1975.
36. Kahn, R. L., Wolfe, D. M., Quinn, R. P., Snock, J. D., and Rosenthal, R. A. *Organizational Stress: Studies in Role Conflict and Ambiguity.* New York: Wiley, 1964.
37. Komoike, Y., and Horiguchi, S. Fatigue assessment on key punch operators, typists, and others. *Ergonomics* 14:101, 1971.
38. Kornhauser, A. *Mental Health of the Industrial Worker.* New York: Wiley, 1965.
39. Kretch, T., and Crutchfield, R. J. *Theory of Social Psychology.* New York: McGraw-Hill, 1948.
40. Lachman, S. J. *Psychosomatic Disorders: A Behavioristic Interpretation.* New York: Wiley, 1972.
41. LeShan, L. Psychological states as factors in the development of malignant disease: A critical review. *J. Nat. Cancer Institute* 22:1, 1959.
42. Levi, L. (Ed.) *Society, Stress and Disease.* London: Oxford University Press, 1971.
43. Levy, L., and Herzog, A. Effects of crowding on health and social adaptation in the city of Chicago. *Urban Ecology* 3:327, 1978.
44. Margolis, B. L., Kroes, W. H., and Quinn, R. P. Job stress: An unlisted occupational hazard. *J.O.M.* 16(10):654, 1974.
45. Mason, J. W. A review of psychoendocrine research on the pituitary-adrenal cortical system. *Psychosom. Med.* 30(5):576, 1968.
46. Monat, A., and Lazarus, R. S. *Stress and Coping: An Anthology.* New York: Columbia University Press, 1977.
47. Morris, J. N., Heady, J. A., and Barley, R. G. Coronary heart disease in medical practitioners. *Br. Med. J.* 1:503, 1952.
48. Naranjo, C., and Ornstein, R. E. *On the Psychology of Meditation.* New York: Viking, 1971.
49. O'Hanlon, J. F. *Boredom: Practical Consequences and a Theory.* Amsterdam: North Holland Publishing Company, 1981.
50. Pilowsky, I., Spalding, D., Shaw, J., and Korner, P. I. Hypertension and personality. *Psychosom. Med.* 35:50, 1973.
51. Sales, S. M. Differences among Individuals in Affective, Behavioral, and Psychological Responses to Variations in Workload. Ph.D. thesis. Ann Arbor, Mich.: University of Michigan, 1969.
52. Schmale, A. H., and Iker, H. P. The effect of hopelessness and the development of cancer. *Psychosom. Med.* 28:714, 1966.
53. Scoth, N. A., and Geiger, J. H. Epidemiology of essential hypertension: Psychologic and sociocultural factors in etiology. *J. Chron. Dis.* 16:1183, 1963.
54. Selye, H. *Stress.* Montreal: Acta, 1950.
55. Selye, H. The evolution of the stress concept. *Am. J. Cardiol.* 26:289, 1970.
56. Selye, H. *Stress Without Distress.* Philadelphia: Lippincott, 1974.
57. Selye, H. *Stress in Health and Disease.* Woburn, Mass.: Butterworth, 1976.
58. Shapiro, D. Obsessive-Compulsive Style. In A. Monet and R. S. Lazarus (Eds.), *Stress and Coping: An Anthology.* New York: Columbia University Press, 1977.
59. Shapiro, D., Schwartz, G. E., and Benson, H. Biofeedback: A Behavioral Approach to Cardiovascular Self-Control. In R. S. Eliot (Ed.), *Contemporary Problems in Cardiology* (Vol. 1): *Stress and the Heart.* Mt. Kisko, N.Y.: Futura, 1974.
60. Shirom, A., Eden, D., Silberwasser, S., and Kellerman, J. J. Job Stress and Risk Factors in Coronary Heart Disease among Five Occupational Categories. In Kibbutzim, *Soc. Sci. Med.* 7:875, 1973.
61. Walker, C. R., and Guest, R. H. *The Man on the Assembly Line.* Cambridge, Mass.: Harvard University Press, 1952.
62. Weiner, H. *Psychobiology and Human Disease.* New York: Elsevier, 1977.
63. Wyatt, S., and Langdon, J. N. *The Machine and the Worker.* IFRB Report No. 82. 1938.
64. Wyatt, S., and Marriott, R. A study of some attitudes to factory work. *Occup. Psychology* March:181, 1951.
65. Yates, J. E. *Managing Stress.* New York: AMACOM, 1979.

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