

How will future worklife influence health?

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Before we can discuss psychophysiological mechanisms relevant to our understanding of future worklife and its influence on future health, we need a theoretical model with which to separate stressors from both individual coping mechanisms and physiological reactions.

The theoretical model (figure 1) introduced by Kagan & Levi (1) and later modified by Theorell (2) can be used to analyze the interaction between different classes of factors relevant to the relationship between work conditions and health. The individual coping patterns are determined partly by genetic factors and partly by life experiences. Since genetic factors determine approximately one-third of the variance in different relevant components of coping patterns (3), the environment is of considerable importance. Our coping patterns are constantly changing due to our experiences. Our experiences at work are embedded in our social context, and conditions outside work, such as social support from family and friends, are also important in determining the health effects of work conditions. In this review the emphasis is on the environmental aspects of the total interplay — with the knowledge that the other parts of the aforementioned theoretical model are also important.

Stressors in the environment

A complex change in both the physical and psychosocial stressors of worklife is taking place. Physical load and toxicologic threats have been decreasing during the past 20 years, while intellectual stimulation and authority over decisions, two important components of decision latitude, have improved (4). Although no causal inference can be made, the incidence of myocardial infarction has decreased during the same period in Sweden for both men and women, for instance in the county of Stockholm (5) (figure 2).

However, during the later part of this period, the number of people temporarily employed has increased dramatically in the county of Stockholm, and there is increasing emphasis on effectiveness. From 1981 to 1991 perceived psychological demands increased among Swedish women and resulted in increased job strain (6). It is not unlikely that this process has continued since then. Thus increasing demands may counteract the beneficial effects of increased decision latitude. However, no consistent negative changes in the incidence of myocardial infarction have been observed, for either men or

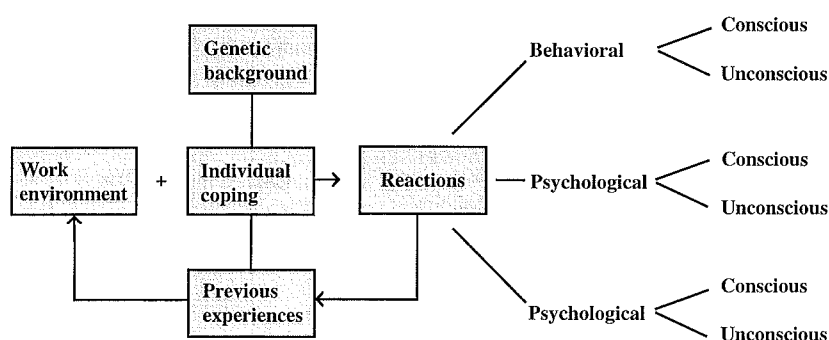


Figure 1. Theoretical model of the interaction between the environment, the individual, and his or her reactions (1, 2).

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women. What has been observed is that the difference — in risk of becoming hospitalized for myocardial infarction — between blue-collar and white-collar workers has been increasing (table 1). This observation could be a reflection of an increasing inequality in work conditions.

Different scenarios for blue-collar and white-collar workers

On one hand, the level of education has increased considerably among the work force, and this change has been accompanied by increasing intellectual discretion and authority over decisions for a large group of workers in the industrialized world.

The demand-control-support model that was originally introduced by Karasek (7) can be used as a framework for analyzing the ongoing changes in the labor market. According to the model, high levels of psychological demands result in adverse health mainly when the

level of decision latitude is low or the social support of fellow workers and superiors is poor. Both decision latitude and social support can thus serve as a buffer against possible adverse health effects of excessive psychological demands. The most unfavorable combination of excessive demands, low decision latitude and poor social support, has been shown to be associated with poor health in many studies. With regard to cardiovascular disease, the most crucial dimension (out of the 3 factors in the model) has been decision latitude.

In the demand-control-support model for the description of stressors at work (figure 3) subjects in technologically highly sophisticated companies are pushed towards the active-isolated part of the cube (7). In this group, mainly corresponding to white-collar workers, the psychological demands are increasing. In large technologically sophisticated companies these groups face increasingly excessive demands, with increasing workhours and demands to be available round the clock, often far away

Table 1. Blue-collar and white-collar workers hospitalized for myocardial infarction in 1981 and 1991 (5). Age-standardized number per 100 000 men between the ages of 40 and 59 years in the county of Stockholm.

	Blue-collar workers (N)	White-collar workers (N)	Risk ratio (blue/white-collar workers)
1981	354	260	1.36
1991	218	144	1.52

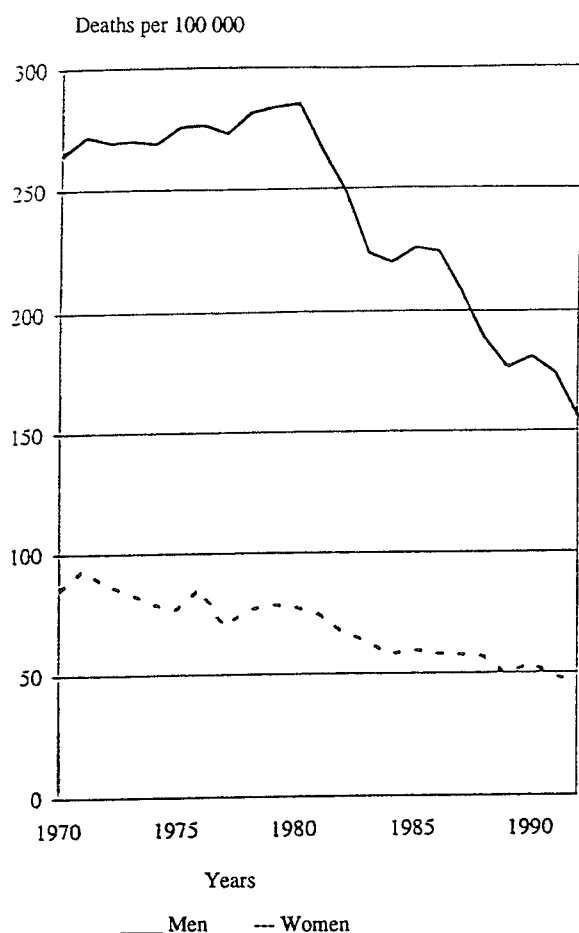


Figure 2. Cardiovascular mortality in 1970–1992. Men and women between 15 and 74 years of age in the county of Stockholm — age-standardized number of deaths per 100 000 (5).

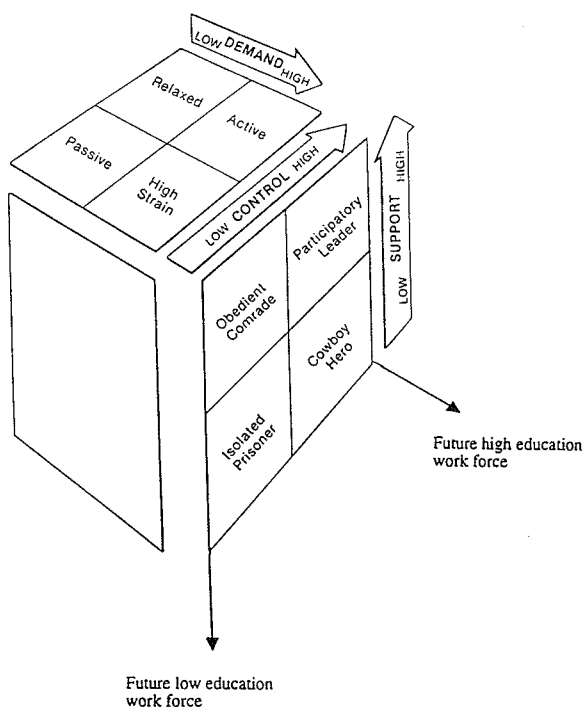


Figure 3. Demand-control-support model for the description of stressors at work by Karasek (7).

from home. Working on home-based computers (during the whole or part of the workweek) and in projects with unstable social networks at work will become increasingly common in these groups. They are compensated, however, by the fact that their work is stimulating and that they are able to influence the work process. It remains to be seen whether this combination will result in an increasing risk of myocardial infarction. So far, low decision latitude has proved to be a more important factor in the elevated risk of myocardial infarction than social support and psychological demands (7, 8), both for men and for women.

At the same time workers with a low educational level are facing decreasing decision latitude since their employment is increasingly of short duration. They are going to have to accept low influence over work conditions during periods of pronounced economic recession. Since the psychological demands will probably increase and the possibilities to establish long-lasting social ties with a defined work group will also probably diminish, this group will move towards the iso-strain (isolation in combination with excessive demands and lack of decision latitude) group in the model. If we extrapolate from previously published studies that have shown that a low decision latitude at work is consistently associated with a risk of myocardial infarction, there is reason to believe that this part of the working population may suffer from a marked increase in such risk in the near future.

In a recent study [the Stockholm Heart Epidemiology Programme (SHEEP)] of full-time working men between 45 and 64 years of age, all cases of myocardial infarction in the Stockholm region were compared with population

referents that were matched with regard to age and geographic region (9). As expected from previous research low decision latitude was associated with increased risk of myocardial infarction [risk ratio (RR) 1.3], even after adjustment for biomedical risk factors, history of chest pain, and social class. The same increase was found for job strain, the combination of high psychological demands and low decision latitude, the addition of psychological demands providing only marginal additional precision in the predictions. An indirect measure of change in decision latitude was also associated with risk. Accordingly, the subjects (25%) who incurred the greatest change in decision latitude when changing jobs during the 10 years preceding a myocardial infarction had an increased risk of developing myocardial infarction (RR 1.4). This phenomenon was particularly evident for workers between 45 and 54 years of age (RR 1.8). Figure 4 shows the percentage of men who reached a deterioration of decision latitude equal to this level in the two groups during each of the 9 years preceding myocardial infarction. The figure shows that the difference between the groups develops during the 4 last years before the onset of myocardial infarction — and particularly so in the workers 45–54 years of age (figure 4). The dynamics of this finding may be important in a future worklife perspective since more and more middle-aged men and women will experience an insecure labor market — with more threats of redundancy and — if they are lucky enough to stay employed — threats of lost status and decision latitude. Accordingly, a delayed increase in the incidence of myocardial infarction among middle-aged men could be expected as a consequence of de-

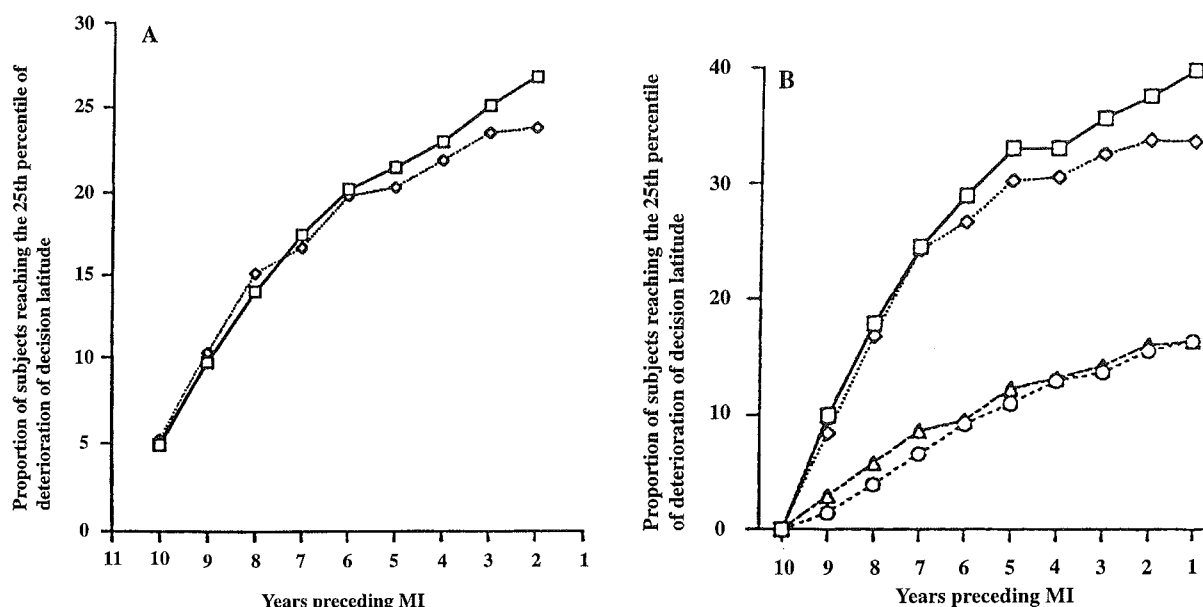


Figure 4. Preliminary data from the SHEEP study. Deterioration of inferred decision latitude among men 45–64 years of age in the county of Stockholm (9). (A: —□— = all cases, ...◇..... = referents; B: —□— = cases 45–54 years of age, ...◇..... = referents 45–54 years of age, ---○--- = cases 55–64 years of age, ---△--- = referents 55–64 years of age)

creased decision latitude. The results clearly showed that workers 45–54 years of age were particularly vulnerable to low or decreasing decision latitude. The reason for this phenomenon may be that men of these ages expect to have increasing decision latitude, and, accordingly, a decrease is perceived as a threat to status esteem. The corresponding findings for women are more difficult to interpret. A low level of decision latitude, however, is clearly associated with an elevated risk of developing myocardial infarction among women, as well as among men.

Physiological demands on adaptation in the past and in the future

During several thousands of years most demands that were made on working men and women were of a physical nature and peoples' bodies were physically adapted to such demands. During the early phases of industrialism, cognitive demands were prominent for many groups of working men and women. With the increasing complexity of the modern world, however, it has become more and more obvious that we are becoming increasingly dependent on social interaction on many levels. Due to the increasing specialization of tasks and the increasing interaction with other groups nationally and internationally, social demands dominate more and more. Physiological reactions to complicated and longlasting social interactions have been studied only to a limited extent.

Physiological reactions

Apart from the fact that the work environment can affect life-style factors and the willingness to adopt "healthy habits" — since a poor work environment may decrease the willingness among employees to follow health advice — several physiological mechanisms may explain the aforementioned relationships between the psychosocial work environment and health. A work situation that evokes a feeling of frustration due to "iso-strain" is associated with the mobilization of energy — *catabolism* — and at the same time decreased *anabolism*. Anabolic processes stimulate the repair and restoration of bodily tissues and are therefore of central importance to vulnerability to the development of somatic illnesses. This is a generalized phenomenon since all tissues need anabolism, the immune system (white blood cells, for instance, are worn out and need to be replaced), the gastrointestinal system (cells in the mucosa are torn), and the muscles (muscles are constantly being

rebuilt to make it possible for the body to adapt itself to changing patterns in the musculoskeletal system), and so forth. The activity in the anabolic systems can be monitored, for instance, by means of assessments of the concentration of reproductive hormones and dehydroepiandrosterone sulfate.

Longlasting exposure to a given type of job stressor gives rise to a series of regulatory and structural changes. In animal research it has been shown that certain cells in the hippocampus, which is part of the stress regulatory system in the brain, actually show atrophy during longlasting stress. Certain kinds of gene expression become gradually more obvious when a stressor becomes longlasting. One of the consequences is that the synthesis of thyroid hormones may accelerate. Another equally important consequence is that the regulation of cortisol production may change. Normally the corticotrophic releasing factor (CRF) in the hypothalamus stimulates the hypophysis to secrete the adrenocorticotrophic hormone (ACTH), which influences the adrenal cortex to secrete cortisol. When the blood concentration of cortisol becomes elevated, the secretion of CRF is inhibited. This interplay between positive and negative influences on the HPA (hypothalamic pituitary adrenocortical) system is of great importance to survival. Its disturbance results in serious bodily problems. For instance, the sensitivity to cortisol increases during long-term exposure to severe stressors, as in posttraumatic stress disorders. This increase is due to both an increased number of cortisol receptors on the cell surfaces in the body and to increased sensitivity of each one of the receptors. Perhaps, as a consequence of this process and the feedback system, the typical finding in posttraumatic stress disorders is low blood concentrations of cortisol during "normal" conditions (10–12).

In major depression CRF is secreted as it should, and the secretion does not seem to be influenced in the normal manner by the high plasma cortisol levels that the high CRF activity leads to. In chronic fatigue one of the problems may be low CRF activity (10–12).

In many physiological situations, the stimulation of energy mobilization is paralleled by the inhibition of anabolism.

One example illustrating the difference between longlasting and short exposure is the observation that the concentration of immunoglobulins tends to increase when job conditions temporarily worsen over a period of several weeks (13), but also decrease when there is chronic exposure to such conditions (14). A simplified interpretation of these conflicting observations is that some of the physiological systems are activated during periods requiring extraordinary effort. If the adverse conditions become very longlasting (several months), physiological resources may be depleted or a destructive form of physiological adaptation takes place. Such a phenom-

enon has been observed to occur also for blood pressure reactions — in persons who have been living with longlasting stressors the magnitude of the blood pressure response to an experimental stressor is attenuated (15).

Interaction with physical stressors

It is important that, for the optimal measurement of reactions to future work conditions, researchers and practitioners take into account the fact that there are many new physical conditions that can potentially change our way of reacting physiologically to adverse psychosocial conditions. One example is longlasting exposure to viral or bacterial infections — some of which are unknown to the scientific world when they start becoming prevalent. Research on the chronic fatigue syndrome has raised the suspicion that a combination of a viral infection and longlasting adverse psychosocial conditions induces a state of exhaustion in the HPA system (10–12). As a consequence, the alarm system of the body cannot be aroused. Research on the state of various aspects of the immune system (13, 14) has indicated that short periods of psychosocial stress exposure (lasting for days or weeks) may stimulate immune activity, while longer periods (lasting for months) may exhaust it. There are also studies which have indicated that chronic exposure to stressors may attenuate acute arousal reactions such as blood pressure elevation in laboratory stress. (See for instance reference 15.)

Another example which illustrates complex interactions between psychosocial and physical stressors is the exposure to electromagnetic fields. We are only beginning to understand the physiological effects of such exposure. Arnetz et al (16) have analyzed endocrine patterns in workers exposed to electromagnetic fields. Those who had symptoms interpreted by themselves as having been induced by electromagnetic fields had a marked serum prolactin concentration during workhours, but not during leisure hours. The interpretation of this finding is difficult, but it can be suspected that the combination of electromagnetic fields and longlasting psychosocial adverse work conditions could have special importance in the physiological state of such subjects.

Social support at work

In the future, working men and women will have to cope with a large amount of social contact. Support at work has been shown to be of essential importance to health. One study (17) has indicated that workers who report poor social support at work have an elevated heart rate

during the day and night. This continuously high heart rate may indicate that there is constant energy mobilization in these subjects. In future work environments, men and women will be more and more dependent on good social relationships in increasingly complex social systems. The highly technological society has so many sophisticated and specialized functions that collaboration will be increasingly important for survival. We already know from occupational medicine of today that longlasting states of job harassment — which arise over many years in subtle conflicts that are difficult to understand — may induce complex disease states that can be a result of disturbed regulation of the arousal systems. Such complicated social processes will be increasingly common. Ways of preventing this will include education in social competence for young people, improved work organization, and improved monitoring of the work environment. Such monitoring could also include physiological parameters.

Physiological measurements

In a changing worklife, feelings of insecurity and lack of social support are prevalent. Unfortunately it will therefore be more difficult to measure reactions to psychosocial conditions by means of interviews and questionnaires, since denial will be a growing problem. Accordingly, physiological measures will be particularly important — “the body’s reactions do not deny”. How human physiology should be recorded, however, is a great intellectual challenge. The number of options is steadily growing, but the real possibilities are limited by the following factors:

- Financial factors: we need measures that are reasonably cheap.
- Practical factors: the measures should be feasible.
- Scientific factors: factors that have no firm basis in previous scientific studies are not feasible in practical studies. It is reasonable to limit the study to only a few identifiable general physiological processes that are influenced by several endocrine factors, for instance, catabolism and anabolism. Two scientific rules could be formulated. First, it is hard to interpret a measurement that was performed only at one point in time — longitudinal measures are always preferable. Second, the measurement of indicators that reflect *different* aspects of endocrinology and metabolism facilitates the interpretation of physiological reactions. There is no single indicator that could give all the relevant information.

- Temporal factors: of importance to the practitioner is the question of whether psychosocial job conditions have a long-term influence on workers' physiology. Indicators that change relatively slowly are preferable to factors that fluctuate rapidly — when long-term effects of the psychosocial environment are concerned.
- Ethical factors: physiological measurements must be performed in such a way that ethical rules are not violated. For instance, employees have to be informed with regard to all types of measurements that are being performed. The conditions surrounding the measurements themselves must take the participants' integrity into account. This is a highly relevant point, for instance, for immigrants who may have been exposed to torture and maybe reminded of the torture by the procedures used in the physiological measurement.

An example from published research serves as an illustration of endocrinological correlates of psychosocial processes during psychosocial job intervention (18). A process that was typical of psychosocial job intervention for white-collar workers was started, with an introductory exploratory phase with interviews of key persons, exploration of the psychosocial environment by means of self-administered questionnaires, feedback to the group, which was being compared with large representative samples of working men and women, and, finally, a structured intervention procedure based upon the information collected. Groups were formed with the task of solving specific problems within specific time periods and the like. Blood samples were collected before and during the questionnaire interrogation, during the discussions of the results of the interrogation, during the practical intervention, and finally 4 months after the end of the intervention.

Two subgroups were identified in the intervention process, one active group, which was characterized by good support from superiors and positive emphasis on structural work (active), and one passive group, which was characterized by lack of support from superiors and emphasis on individual counseling in the process (passive). After an initial rise in serum cortisol (from very similar levels in the 2 groups) the mean level decreased in the active group and increased in the passive group during the intervention. Testosterone concentration, in both the men and the women, tended to rise in all the groups, but particularly so in the active group. The findings may illustrate that psychophysiological uneasiness was more frequent in the passive group and that stimulated anabolism was more frequent in the active group. They may also illustrate that the measurement of physiological parameters could increase our possibility to understand psychosocial processes. The importance of the support of superiors was illustrated. Other endocrinolog-

ical measures were also made which illustrated that the psychophysiological costs and gains differed for the men and women since there were different patterns of reaction with regard to prolactin, a hormone that seems to reflect powerlessness in crisis situations.

Denial and lack of ability to describe emotions (alexithymia)

Unfortunately, it is not always possible to obtain the most relevant information regarding work conditions by means of self-administered questionnaires and by means of interviews. For instance, in many cases, denial and alexithymia are more frequent phenomena among subjects who are particularly vulnerable to the development of serious cardiovascular illness (19). This may be the case particularly with the early onset of hypertension and sudden unexpected cardiac death. An ongoing study has shown that professional drivers who are exposed to acute experimental stress conditions simulating real traffic situations react both with their central nervous system (electroencephalographic recordings) and their cardiovascular system in a way that is associated with a risk of developing heart disease. The psychophysiological reaction pattern, which could be characterized as a delayed intensive reaction to the standardized stimuli, is associated with the amount of exposure to professional driving. The drivers who claimed the least anxiety and the least psychological reactions to the situations showed more vigorous psychophysiological reactions than the others and also more denial (20). This phenomenon again illustrates the importance of psychophysiological recordings in the efforts to monitor future worklife and, furthermore, mirrors the difficulties that will be encountered if we rely exclusively on self-administered questionnaires.

Concluding remarks

The genetic influence on psychosomatic mechanisms has been estimated to account for approximately one-third of the variation in psychosomatic health. Thus the environment — including the work situation in the future — will always be of great importance. Due to the structural development, with increasing demands on effectiveness and increasing threats of becoming unemployed, employees will be more and more reluctant to report problems at work. Accordingly, the foreseeable development will necessitate increasing emphasis on external ratings of the psychosocial work environment and on physiological monitoring. It will be particularly important to study

long-term consequences of the new work environment. The understanding of the association between the environment and the regulation of energy mobilization and anabolism will be of central importance.

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