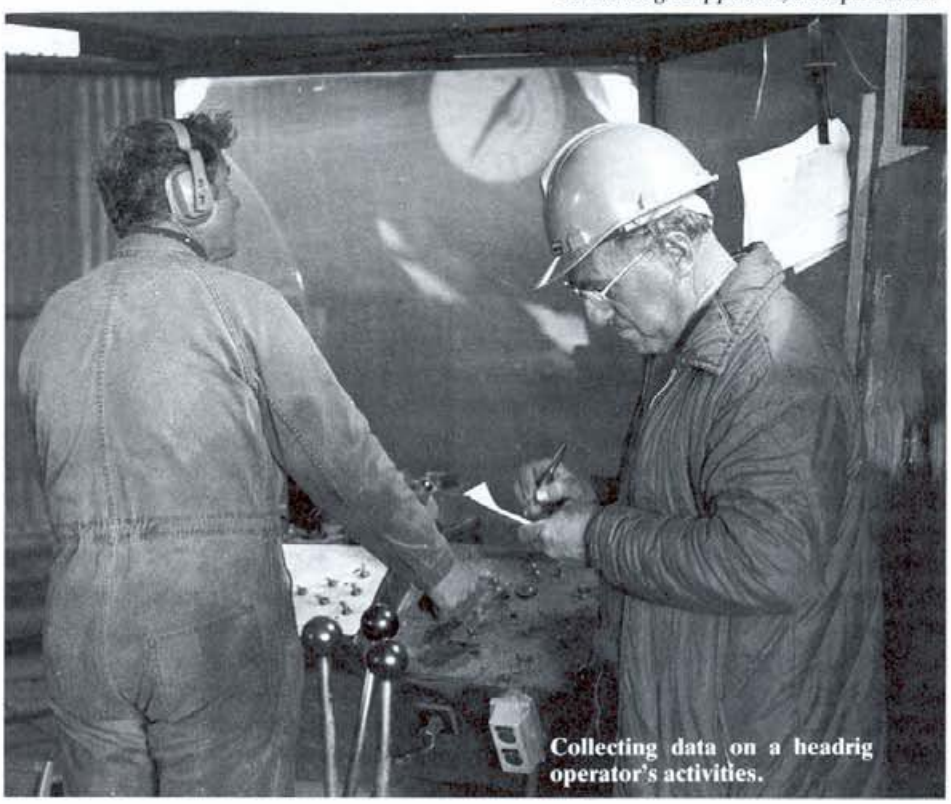
When you feel taxed — a new stress test

'Actually I enjoy my work when the assignments are large and urgent and somewhat frightening...I get scared, and am unable to sleep at night...'

Something Happened, Joseph Heller



Collecting data on a headrig operator's activities.

You get out of bed on the wrong side. Argue with your spouse, shout at the kids. Miss breakfast. Arrive at the office only to be told that you have an impossible deadline to meet. Chain smoke, work late, recover with a few drinks. You're coping with stress.

This scenario, often painted to illustrate the 'Type A' personality — competitive, hostile, and restless — is familiar to many of us. Stress has become one of those shorthand words invoked to explain why life in the 20th century seems more difficult than life before production lines and computers.

Too much stress in the long term may lead to serious health problems — cynics already talk about one-, two-, and three-ulcer jobs. In America, the Institute of Stress has calculated that stress-related illness costs the United States economy $158 000 million a year, 10 times more than all strikes combined. Although nobody has done a comprehensive study on the cost of stress-related diseases in Australia, the few researchers who have been studying stress estimate that it costs about 2% of the Australian Gross National Product — $4000 million a year.

Fight or flight

Scientists and doctors interpret 'stress' to mean the observable behavioural and physiological changes that take place in response to environmental demands. Some level of stress is always present in the body. But when confronted by a snorting bull or an enraged boss, for example, our first reaction is one of alarm — the familiar 'fight or flight' response.

In the arena of today's office, we don't really fight or fly in the face of stress. Rather, we try to stay cool — perhaps smoke another cigarette or snap at a subordinate. Although coping on the surface, many employees may be suffering from an overload of mental and, less often, physical work. How can employers recognize the condition?

The symptoms vary between individuals, and researchers can use the sufferers' own descriptions, and their behaviour or physical condition, as indices of stress. Anxiety, headaches, upset stomach, and insomnia often herald ulcers, high blood pressure, and more severe symptoms. Ideally, stress needs to be diagnosed at an earlier stage.

Most of the research findings on the biochemical changes elicited during stress came from animal experiments. They show that, when the pressure is on, the cerebral cortex sends out an alarm signal to the brain-stem, which, among other things, stimulates the adrenal glands to release two hormones — adrenaline and noradrenaline — into the bloodstream.

These increase the rate and strength of heartbeat, so that more blood and oxygen are pumped around the body. The spleen contracts, releasing red blood cells, and sugar stored in the liver is released into the bloodstream for muscle fuel; noradrenaline also extracts fuel from fat deposits.

Sawmills

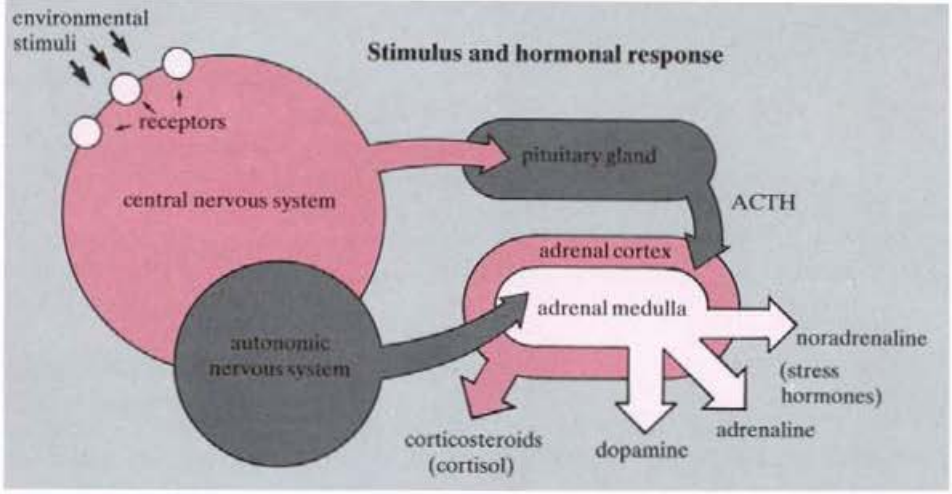
Dr Waldemar Fibiger, formerly of the CSIRO Division of Chemical and Wood Technology but now working in collaboration with the Brain-Behaviour Research Institute of the LaTrobe University in Melbourne, has been investigating ways of using physiological indices to monitor people's physical and mental workloads. He began this work while with the Division's timber conversion program, which had recognized the need to study the workload of certain types of sawmill workers. Mr Frank Christensen, the program co-ordinator, collaborated with Dr Fibiger throughout the 5-year study.

Traditionally, the Australian sawmill industry has been labour-intensive and poorly capitalized. The working environment has been noisy, unattractive, and uncomfortable, with often only a gal-

Hormonal ratios measured in student subjects during 'real-life' situations. Low ratios went with mental effort; high ratios with physical effort.

Day-to-day effort

activity	noradrenaline: adrenaline ratio
physical effort	6
reading professional journals	3
work at desk	4
laboratory work	3
computer work	3
writing reports	2



The hormonal release pattern differs depending on the type of environmental stimulus.

vanized-iron roof to protect workers against extremes of heat and cold. Noise interferes with communication between workers, disturbs attention and concentration, and can lead to progressively impaired hearing ability.

In 1983, Dr Fibiger and Mr Christensen carried out a survey on workers in four highly mechanized hardwood sawmills. The workers complained that the long-standing sources of annoyance were, indeed, dust, noise, and severe heat and cold.

But the recent introduction of high-production-rate machinery had changed the balance of the workload for some people from mainly physical to largely mental. So new annoyance factors emerged, like the demands for continuous thinking, concentration, simultaneous attention to a number of items, and fatiguing repetition of the same movements many times per day. Among the 25 annoying factors examined, workers gave these virtually the same ranking as noise, or heat and cold.

The added mental workload seemed to have increased the level of occupational stress among the sawmill workers, which in the long term could affect their health and well-being. To evaluate this thinking component, Dr Fibiger and his colleagues used the simple, non-invasive monitoring technique of measuring the urinary concentrations of adrenaline and noradrenaline at regular intervals during the working day.

Dr Fibiger — together with Professor George Singer of the Department of Psychology at La Trobe University and Dr Alan Miller of the CSIRO Division of Mathematics and Statistics in Melbourne — had demonstrated the validity of the technique in experiments where they found correlations between hormonal changes, time of day, and the mood of the subject. These researchers measured the urinary concentrations of adrenaline and noradrenaline in student subjects throughout physical and mental test sessions, and during a week of real-life stress.

Physical or mental

These experiments revealed that the response of the body to the demands of the work environment, as reflected by the excretion of stress hormones in the urine, can be used for sorting out the physical and mental components of the workload. Dr Marianne Frankenhaueser of Stockholm University in Sweden had already proved that the two hormones are sensitive to psychological stress. Her studies showed that adrenaline increased with stress, while noradrenaline did not appear to be related consistently to mental strain.

Physical and mental effort evoke different hormonal response patterns.

Although noradrenaline and adrenaline are subject to daily variations, the team's results showed that physical and mental effort evoked different response patterns in the adrenal medulla — the inner part of the adrenal glands, which sit on top of the kidneys. These differences were reflected in the noradrenaline to adrenaline ratio.

During physical exercise, noradrenaline excretion increased at a rate roughly proportional to the level of physical work. During mental tests, however, excretion of adrenaline increased without a corresponding increase in noradrenaline. The ratio of noradrenaline to adrenaline was consistently found to be more than 5 for physically taxing work, and between 2 and 3, or even lower, when the load was largely cerebral. Smoking, alcohol, and coffee did not appear to affect the ratio.

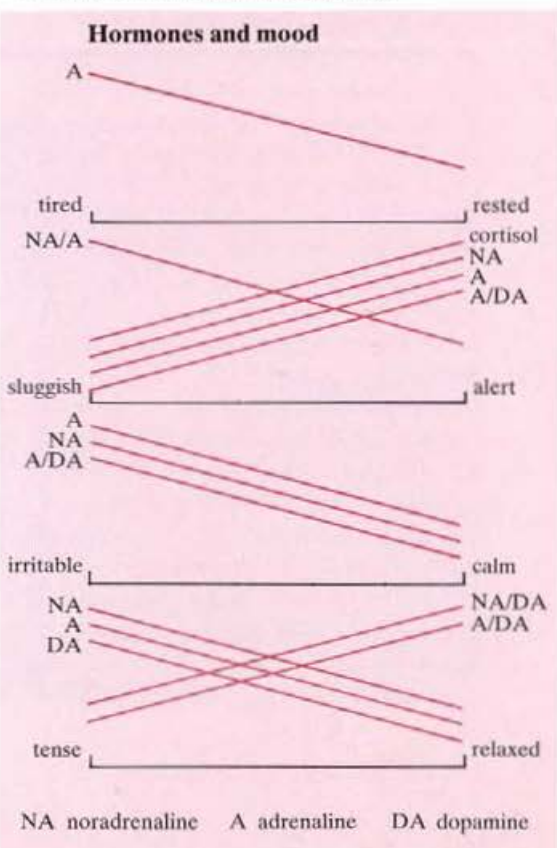
The advantage of using such a ratio over the use of absolute excretion levels of hormones is that it can discriminate not only between 'pure' mental and 'pure' physical effort, but also between cerebral effort and a combination of both muscle and brain effort. Further, use of the ratio eliminates complications due to differences in hormone levels between individuals and between times of day.

More than 10 different hormones appear to be involved in reactions to stress. Adrenocorticotrophic hormone (ACTH), when released from the pituitary gland at the base of the brain, acts on the outer edge of the adrenal glands and stimulates the release of another hormone, cortisol. Cortisol mobilizes the body's energy stores and increases the amount of sugar and fat in the blood. It also depresses the body's immune system, and in the long term may depress sexual behaviour.

Dr Fibiger and his colleagues analysed changes in the urinary levels of cortisol and other stress hormones in the university students, and related the results to the self-assessed mood of the subjects. Briefly, adrenaline again accumulated with physical fatigue, and cortisol levels increased with the level of alertness. The higher the level of stress became — as assessed by the students' feelings of tenseness and irritability — the higher the release and urine excretion of adrenaline, noradrenaline, and dopamine.

Medical researchers have recently been focusing attention on dopamine, because it seems to be involved in the control of the cardiovascular system. They have found

A generalized picture of the relations between hormones, hormonal ratios, and different 'mood' scales. The tired–rested scale refers to physical arousal, sluggish–alert to mental arousal, and irritable–calm and tense–relaxed to mental stress.



A resaw operator with the joystick and console controls that he has to operate up to forty or more times per minute throughout the working day.

that it accumulates in the urine, and varies in level with physical exercise: sustained exercise causes an increase in blood dopamine levels. So, rather than being simply a precursor of noradrenaline and adrenaline, as had been believed earlier, dopamine seems to have a specific functional role of its own.

Six categories

In their sawmills survey, Dr Fibiger and Mr Christensen examined sawmill workers grouped into six distinct categories: headrig operator, band resaw operator, circular resaw operator (two groups), wood grader, and dockerman. They found graders and dockermen, who had to turn or push each piece of timber by hand, had the highest physiological workload in terms of energy output. They also showed the highest noradrenaline to adrenaline ratio, indicating a high level of physical rather than mental effort.

Low energy output and a low ratio of noradrenaline to adrenaline characterized the jobs of the headrig and band resaw operators. These results are consistent with the workers' own assessment that their mental workload was high and tiring.

In fact, for all categories, measurements of work tempo and stress hormone ratios agreed with the workers' self assessment of the relative physical and mental demands of their jobs.

The headrig and band resaw operators also had the highest excretion of adrenaline. Experiments in the United States have linked sustained high levels of adrenaline to the development of coronary heart disease.

As well as heart disease, some evidence suggests that stress may cause cancer and infertility. Cortisol, in particular, has been implicated. Animal studies have shown that stressed rats are less able to protect themselves from implanted tumours, and are more likely to get cancer than relaxed rats, perhaps because their immune system is depressed by the cortisol released during the stress response.

Dr Fibiger and his colleagues have suggested one remedy for reducing stress in work-places such as sawmills. Rotating the jobs of all operators during each working day would relieve tedium and excessive mental strain. Although this would require the training of all operators to perform all jobs, the reward for the employer should be increased productivity.

The research of Dr Fibiger and his colleagues indicates that measuring noradrenaline and adrenaline excretion levels among employees could contribute to the routine monitoring of stress in the workplace. The success of changes in work practices designed to reduce stress could show up in noradrenaline : adrenaline ratios that were consistently neither too high nor too low.

Mary Lou Considine

Static and dynamic loads

In a separate series of experiments, Dr Fibiger and Mr Mel Henderson, formerly of the Division of Forest Research in Canberra and now a doctoral student at La Trobe University's School of Behavioural Sciences, measured the physiological cost of tree-felling to workers thinning pine plantations. The cost in this case was measured by oxygen consumption, ventilation, and heart rate.

The results showed that the workers were indeed overloaded. This partially accounted for a high labour turnover, especially of older fellers or those with a relatively low physical working capacity. The heart-rate analysis revealed a constant overload of the circulatory system throughout the whole of the working day. A decrease in work tempo in response to overload hid any fatigue effects.

The feller's job is characterized by high static load — the work is postural (bending over to trim logs, etc.) rather than dynamic and rhythmic. This causes local fatigue in muscles more quickly than does high dynamic load. Dr Fibiger and Mr Henderson concluded that, because the fellers had no formal training, most of them were bending, leaning, and trimming their way to premature fatigue.

They were able to make a number of recommendations to the industry. Team work — for example, working in pairs — would allow fellers to alternate their tasks throughout the day. Reducing the static load could be effected through formal training and modified felling techniques. Selection of novice fellers is also important — only those with a high physical working capacity should be considered.

More about the topic

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