RESPONSE OF THE PITUITARY-ADRENOCORTICAL SYSTEM TO MENTAL STRAIN IN HEALTHY WOMEN

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About fifteen years ago, Cannon (1) observed the "emergency reaction" in cats in which he demonstrated the essential importance of epinephrine in producing such a reaction. This evidence shows that any mental strain will induce an immediate secretion of epinephrine.

On the other hand, Selye (2) showed experimentally that in animals under stress there was a hypersecretion of adrenal cortical hormones. He called this the "alarm reaction." In 1947, Pincus (3) reported the involution of lymphatic tissues by psychomotor stress, and suggested that assessment of mental fatigue would be possible by lymphocyte count and by 17-ketosteroid determination in the urine. More recently, Thorn and his collaborators offered the eosinophil-count test for measuring adrenocortical insufficiency. This was made by the administration of either pituitary adrenocorticotropic hormone (4) or epinephrine (5). We also realized independently, the possible use of epinephrine for testing adrenal cortical activity (6).

It is clear from numerous studies on the physiology of the effects of strain that the sympathetic-adrenal system first initiates the process which is then supported by the pituitary-adrenocortical system. This evidence has been recently reviewed in details by Sayers (7). There, he used the word hormonal "utilization," instead of Selye's "catabolic impulse" (8).

In daily routine, we experience so much emotional and mental strain that it would be useful if we could quantitatively evaluate the degree of strain. Based on the above evidence, the present study was undertaken to determine the possibility of measuring mental fatigue by the eosinophil count.

METHOD

Four healthy female students of 18 to 20 years of age were made to sit calmly in a quiet room for one hour before experiments were done. At ten o'clock in the morning, 1 cc. of blood was drawn from the cubital vein and was placed in a dried test tube containing crystals of combined oxalates. Immediately after this procedure, subjects were ordered to multiply a pair of two unit figures on the paper as fast as possible. This work was made to continue for exactly two hours followed by two hours of relaxation. The second blood sample was

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taken at the beginning of this rest period, that is, at about noon: after one hour and two hours rest, the third and fourth samples were taken respectively. As controls, blood was drawn from subjects merely sitting for five hours without work in the same room.

Eosinophils in the oxalated blood were calculated for absolute number by our modification (9) of the standard method of Dunger-Thorn (4). Total white cells were also counted several times, because they are generally increased by the administration of pituitary-adrenocorticotrophic hormone although this tendency is not consistent.

RESULTS AND DISCUSSION

The fall or rise in the number of eosinophils expressed in percentages of the initial counts (at ten o'clock) is illustrated individually in figure 1, comparing the values for days of stress to those on control days. Figure 2 shows the average trends of two groups. The sustained drop in the number of eosinophils under mental stress was highly significant \( (P<0.01) \) compared with the control level. The change in total white cells was found to be irregular, and appeared insignificant.

According to Long (10), sensory stimuli or emotional stress causes reduction in both ascorbic acid and cholesterol content of the adrenal cortex in animals.
Therefore, the results obtained in this study are not surprising. At present there are no adequate tests for measuring the amount of fatigue or the amount of impairment caused by mental strain. However, it is hoped that by further application of this type of study we may develop an adequate quantitative test for emotional and mental fatigue. Such a test should also be simple for practical application.

This same method was used to investigate the fatigue of telephone operators.

An investigation for measuring fatigue was undertaken at the beginning of April, 1950 at the Central Telephone Office in Tokyo. Twelve telephone-operators (girls) were examined for a week. Blood was drawn twice a day from the cubital
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Vein, both before and after their work hours. It was directly counted by our method. The fall in eosinophils was most remarkable during night work (figure 3). Among several items of examination simultaneously undertaken (e.g., pulse rate, blood pressure, the threshold of patellar reflex, proper salivation, and so on), the eosinophil-count test was found to be most convenient and reliable, although this investigation was only preliminary in nature. We were convinced that further studies should be undertaken with this method.

Summary

Four young female students subjected to the mental strain of calculating unit figures continuously showed a remarkable decrease in the number of circulating eosinophils (average of 26 per cent in two hours). The result suggests that the pituitary-adrenocortical system was stimulated to such a degree that the “alarm reaction” was initiated, and that the circulating level of cosinophils was lowered due to mental strain.

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