EXPERIMENTAL FINDINGS ON THE SECHENOV PHENOMENON IN DYNAMIC WORK

COMMUNICATION I. TYPES OF CHANGE IN MUSCULAR WORK CAPACITY AFTER PASSIVE AND ACTIVE INTERRUPTIONS

I. M. Trakhtenberg and I. V. Savitsky

From the Department of Industrial Health (Chairman Prof.G.Kh. Shakhbazyan)
Kiev Medical Institute (Director L. P. Alekseenko)

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I. M. Sechenov, who was one of the first to occupy himself with the study of the physiology of labor processes, showed that for the restoration of muscular work capacity of importance is not only the duration, but also the character (form) of rest [3]. It has been shown that the most effective form is the active form of rest, obtained experimentally, and known as the Sechenov phenomenon. The concept of the physiological bases of the "Sechenov effect" in raising work capacity is of crucial importance for the rational organization of active rest and the working out of a suitable regime

It is known that in production with the rational organization of rest it is necessary that in the course of short breaks the level of work capacity should return to the original level. A suitable regimen is so established that the beginning of each subsequent work period coincides with an optimal degree of restoration in the preceding rest period. One may assume that the beginning of the subsequent work period with muscular dynamic activity after active rest coincides with the later stage of rest, when the work capacity is at a relatively high level, while with the same dynamic work, but following passive rest, the next work period will be renewed at the earlier stage or rest, when the work capacity has not yet been restored.

M. V. Leinik [1] noted experimentally, that after execution of muscular work during rest, four stages are observed, each of which is marked by a different level in the individual indices (muscular power, prefatigue period, fatigue), with a different ratio between them. It was shown that change in work capacity of the muscles and in the type of change during work with breaks depends on that stage of rest in which renewal of each subsequent work period takes place. In the case when the commencement of muscular activity coincides with the first stage of rest, the capacity of work change belongs to the so-called category A; compared with what was observed in the preceding work period, muscular power and prefatigue period diminish and fatigue increases. Renewal of work in the second stage determines a category B change in work capacity; muscular power and fatigue are increased and the prefatigue period is reduced. Thus, from the point of view of subsequent work capacity, the second stage of rest is more favorable. The following stage is even more favorable. The commencement of work in this stage determines category C change in the work capacity of the muscles: the level of muscular power is the same as in the preceding work, the prefatigue period increases, fatigue diminishes. Commencement of work coinciding with the final stage of rest causes a category D change in work capacity: muscular power and fatigue are less, the prefatigue period greater (in comparison with the indices in the "original" work).

Method of Investigation

Measurement of the work capacity of the muscles was conducted by a tracing on an ergograph. In the first series, the subjects performed work with the right hand to complete exhaustion with a load of 2 kg for women,

and 3 kg for men. The work was carried out to the accompaniment of the noise of a metronome at the rate of one beat a second. In the process of muscular activity, after separate periods of work, two minute breaks were arranged, of which the first two were passive and the following ones active (with a load in the left hand of 1 kg for women, and 2 kg for men). The observations were conducted on a group of students (63 in all, 36 men, and 27 women).

In the second series, the subjects performed work with the right hand for one minute with a 3 kg load. Periods of work were separated by breaks of two minutes, in some tests passive, and in others active (with a load of 2 kg in the left hand). In each test the periods of work and rest were alternated four times. Altogether 42 investigations were conducted on eight students aged from 22 to 30.

Comparison and analysis of the results of this series were carried out according to the method worked out in the laboratory for the study of muscular activity of the Kiev Institute of Industrial Health and Industrial Disease [2]. With this, were determined: 1) muscular power (according to the average height of the myograms in millimeters); 2) prefatigue period (according to duration in seconds); 3) degree of fatigue (in percentages). By comparing the indices indicated in the "original" work with those of the proceeding work, different types of change in muscular work capacity were determined (A, B, C and D, according to M. V. Leinik [2] enabling one to judge in which stage of rest each subsequent work period was renewed.

Results of Investigations

In the first series of experiments it was established that with comparatively long, dynamic work in conditions of uniform alternation of active and passive rest breaks equal in duration, different variants of change in muscular work capacity are observed (Fig. 1). The presence of these variants may indicate in particular that the subsequent renewal of activity in relation to this or that condition (degree of previous fatigue, degree of training, original functional state of the motor analyzer, etc.) coincides with different stages of rest. Hence the different degree of restoration of work capacity observed during the subsequent work.

The findings set out in Fig. 1 show that even with the presence of some variants in change of work capacity of the muscles, the latter, as a rule (in 55 out of 63 subjects), after active rest is higher than after the passive rest. Apparently, the form of rest is one of the conditions determining the renewal of the subsequent activity in the corresponding period (stage) of rest. The question as to which stages of rest in which each succeeding work period is renewed in the dynamic activity process following breaks, was especially studied in the second series of experiments.

Generalization and analysis of the findings showed that the ratios of the indices which we took as criteria characterizing the work capacity of the muscles, as a rule, after active rest differed from those after passive rest. The character of the changes of these ratios enables one in the main to place in categories B and C the work carried out after active rest, the first category of which is distinguished by a higher (in comparison with the preceding work) level of muscular power, the second category by an increase in the magnitude of the prefatigue period and a reduction in the degree of fatigue. In other words, after the breaks with active rest, "favorable" types of changes in the work capacity of the muscles are seen. At the same time after breaks with a passive rest, the change in work capacity, as a rule, takes place in line with the "unfavorable" category A, with an increase in fatigue, a lessening of muscular power and a decrease of the prefatigue period (Fig. 2).

It is significant that, even in those individual case (5 out of 22) in which, after active rest, work capacity of category A was observed, the indices of muscular power and the prefatigue period were higher than with the same category of change in work capacity after passive rest. The indices of the degree of restoration of work capacity were also higher.

The table includes as an example the indices of the first two periods of work, with breaks for passive and active rest in the subject T (category A change in work capacity).

Thus, analysis of the types of change in muscular work capacity after active rest allows one to consider that the commencement of each succeeding work generally coincides with a later (favorable for the subsequent effect) stage of rest. At the same time, after rest of the same duration, the commencement of each alternating work, judged by category of change in work capacity, coincides with earlier (less favorable for the subsequent effect) stage of rest.

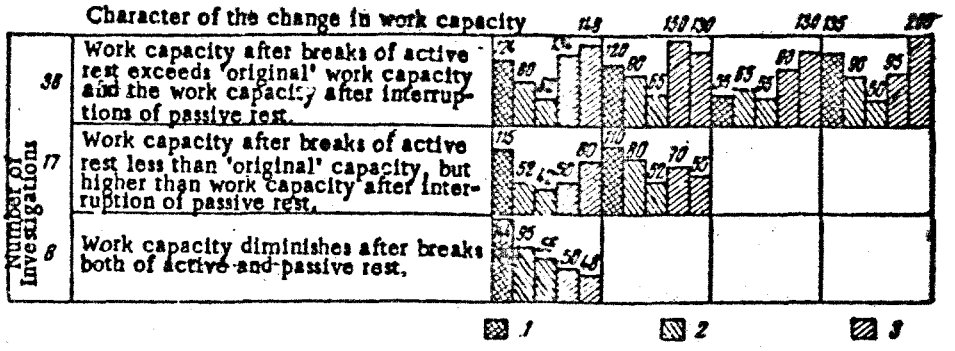
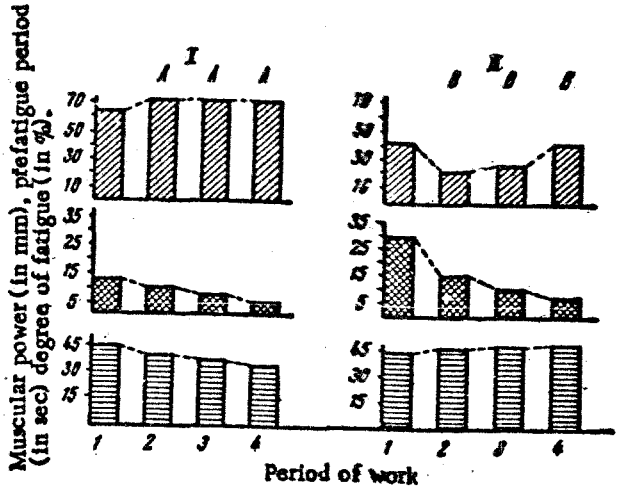


Fig. 1. Change in work capacity of muscles (in seconds) in the process of dynamic work with two minute breaks for passive and active rest.
1) Original work capacity; 2) work capacity after passive rest; 3) work capacity after active rest.



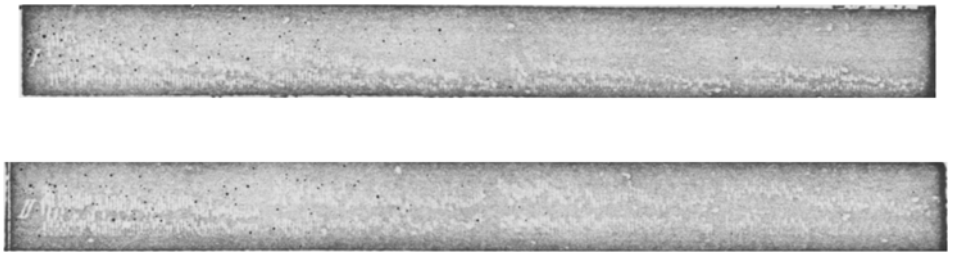


Fig. 2. Change in indices of work capacity of muscles after individual breaks in relation to the indices in each preceding period of work: I) after passive rest; II) after active rest.
A, B) Type of changes in work capacity. Below — the corresponding ergograms.

Consequently, with the same duration of breaks, but with different forms of rest (active, passive) different time intervals are necessary during which rest takes place through individual stages. In other words, for the completion of the individual stages of rest with active breaks, less time is required than with breaks of passive rest. This suggests that the speed of the course of the restorative processes with active rest is considerably higher than with passive rest — naturally within specific bounds, limited by known conditions of activity (duration, intensity, degree of developing exhaustion, etc.). Apparent confirmation of the latter is found in cases where the "Sechenov effect" of the increase in work capacity does not manifest itself,* which also coincides with the

* The second communication is devoted to the clarification of this question.

point of view of G. V. Folbort concerning the physiological basis of the phenomenon considered [4].

Change in the Indices of Work Capacity of Muscles and its Degree of Restoration after Passive and Active Rest in Subject T

Index of Work Capacity	Work with passive rest		Work with active rest	
	Original	Second	Original	Second
Muscular power (in mm)	44	40	44	43
Prefatigue period (in seconds)	33.7	20.6	30.3	22.5
Degree of fatigue (in percentage)	43	48	45.5	50
Degree of restoration of muscular power (in percentage)	—	91	—	98
Degree of restoration of the value of prefatigue period (in percentage)	—	61	—	75
Degree of restoration of work capacity according to amount of work performed (in percentage)	—	85	—	97

The results of the investigations allow one to consider that, given rational organization of active rest, the types of change in work capacity can be used along with other physiological indications as one of the criteria for estimating the effectiveness of rest.

LITERATURE CITED

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*In Russian