

# EXPERIMENTAL DATA ON SECHENOV'S PHENOMENON DURING DYNAMIC WORK

## Communication 2

### CHANGES IN EFFICIENCY IN THE PROCESS OF PROLONGED MUSCULAR ACTIVITY WITH PASSIVE AND ACTIVE INTERRUPTIONS

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In a previously published communication [12], we presented experimental data regarding the types of changes which occur in muscular efficiency after "passive" and "active" interruptions of dynamic work. The varying nature of the dynamics of the changes in the muscular efficiency of various persons and of the same subjects in analogous experiments, which were observed by us, apparently indicate that the re-establishment of muscular efficiency after short-term interruptions of a process of muscular activity depends on a number of factors: the intensity and duration of the work done, the nature of the rest, the degree of training of the subjects, the initial functional condition of the motor analyzer, etc.

One of the factors which has a considerable effect on muscular efficiency is the degree (intensity) of fatigue which develops in the process of muscular activity. In particular, there is a basis for assuming that the increase in, decrease in, and disappearance of increased muscular efficiency after active rest also has a definite relationship to this factor. Further investigation of this problem can have a certain interest from the point of view of understanding the nature of the mechanism of Sechenov's phenomenon.

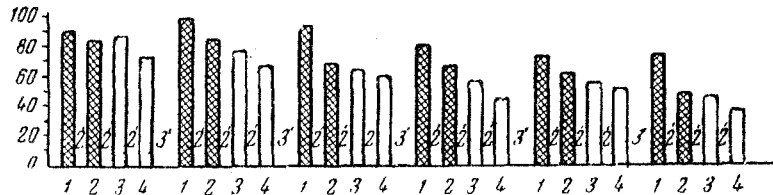
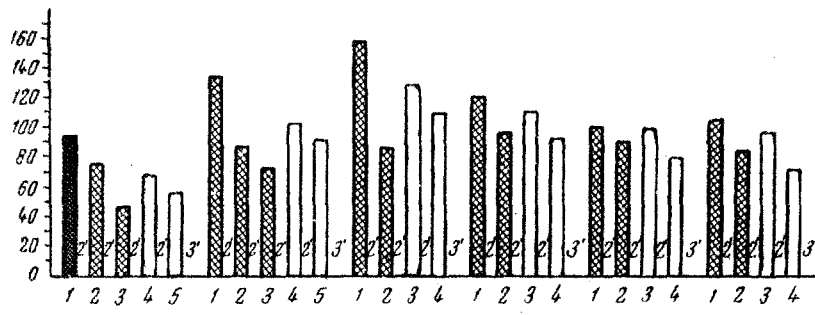
#### EXPERIMENTAL METHODS

Work was done on a digital ergograph by the right hand with a weight of 3 kg for men and 2 kg for women until complete fatigue. The weight was raised in time to a metronome; one beat per second. 2-minute intervals were established between separate work periods; passive rest after 2-3 work periods; then active rest. Active rest consisted of work with the left hand on another ergograph with a weight of 2 kg for men and 1 kg for women. In each investigation the individual "work unit" consisted of 4-5 periods of the work described above and was repeated 8-12 times with interruptions of 3 minutes. Thus, prolonged muscular work on the ergograph was composed of individual work units, each of which included several work periods (until complete exhaustion) with passive and active interruptions. The observations were carried out on 7 subjects ranging in age from 20-30 years; 4 men and 3 women.

#### EXPERIMENTAL RESULTS

The dynamics of the change in muscular efficiency of subject S., noted in the process of prolonged work on the ergograph, are represented graphically below (see drawing). A similar type of change in efficiency was observed in the other subjects also.

As is evident from the drawing, the increased efficiency after active periods grows gradually in comparison with the initial indicators (first work unit), reaching the highest level at a certain stage, then it begins to decrease.



Dynamics of the change in muscular efficiency during prolonged work on the ergograph (subject S).

Black column - initial work, cross-hatched column - work after passive rest, white column - work after active rest; 1, 2, 3, 4, 5, -work periods. Numbers between columns - interruptions of work in minutes.

The comparison of the above dynamics of the change in muscular efficiency after active interruptions with the dynamics observed in the same experiments, but after active rest, is of interest. The degree to which muscular efficiency is re-established after passive interruptions, as after the active ones also, increases from work unit to work unit, then gradually decreases, reaching the initial level at a certain stage. At the same time, it draws attention to the fact that while the degree to which the efficiency is re-established during the second half of the muscular activity after active interruptions is at its lowest level, in comparison with the initial one, the degree to which the efficiency is re-established after passive interruptions still remains at a fairly high level, surpassing the level observed at the beginning of muscular activity.

The results of these experiments show, thus, that the degree to which muscular efficiency is re-established after passive and active interruption during a period of dynamic work depends to a great extent on the fatigue which develops in the process of muscular activity. A gradual increase in the degree to which the efficiency is re-established at the first stage of prolonged muscular activity, after both passive and active interruptions, apparently, can be explained by an increase of the inhibition in the corresponding center as a result of the growing fatigue as further work is performed. The decreased degree to which the efficiency is re-established observed later, is connected with the fact that the fatigue which develops during the process of prolonged work on the ergograph begins to acquire a more evident and stable nature at a certain stage (during the second half of muscular activity). At the same time, apparently, the nature and mobility of the inhibition developed in the nerve center changes, which can lead to the weakening of its stimulant effect on the regeneration processes. The possibility of such a change in the normal relationships between inhibition and regeneration is indicated in the work of G. V. Folbort. Another hypothesis is also possible: the change in the mobility of the developing inhibitory process as a consequence of "excessive" preliminary fatigue is primarily evident in the stagnant nature of the inhibitory process. This, in turn, can lead to the fact that subsequent muscular activity, occurring against a background of a certain inhibition of the nerve centers, can differ from the preceding activity by a considerable decrease in efficiency. It is possible that the reason for the weakening of Sechenov's effect of increased efficiency during prolonged dynamic work (as well as the reason for its strengthening during the first stages) should also be sought in the nature of the inhibitory process which arises. This also refers to the disappearance of the effect of active rest which we observed during the last work periods. It is known that the reinforcement of

the inhibitory process during the period of active rest is based on the negative induction from the area of excitation which arises due to the afferent impulses from the working muscles. It is also known that the negative induction subsequent to the cessation of the basic work preceding active rest also has significance\*. Apparently, the fatigue which develops in the process of muscular activity facilitates the further reinforcement of the inhibitory process. As the result of this "summation" of the above effects, the inhibition which develops in the center can acquire an even more profound nature than in those cases in which one of these factors acts preeminently: either active rest or the preceding fatigue. However this "summation" of effects and the inhibitory process, which is a consequence of this increase and which determines the higher efficiency after active periods in comparison with the initial efficiency, proves to be advantageous only to a certain point. As further work is performed, when the developing fatigue reaches a very considerable degree, as a consequence of which the level of efficiency begins to approach the initial state, the "lamination" of active rest, apparently, leads to overstraining of the inhibitory process, as a result of which the "Sechenov effect" of increased efficiency disappears. Hence the paradoxical, at first glance, fact that, in the presence of evident fatigue the lowering of efficiency after passive interruptions (without "laminating" inhibition due to active rest) occurs less intensively and to a lesser degree than after active interruptions, becomes understandable. The data which were obtained allow the hypothesis that the absence of the effect of active rest in individual cases and with considerably less prolonged work (see the first communication) is also connected with the nature of the inhibitory process as suggested above. It can be hypothesized that the preceding muscular activity (either alone or in combination with work during active rest) was excessively fatiguing for persons who do not show the effect of increased efficiency after active rest. The data which were obtained should be taken into account when utilizing active rest in the practice of the rational organization of a suitable regime.

#### SUMMARY

Intensification, relaxation and disappearance of working efficiency effect after active rest depend upon the degree of fatigue developing with muscular action. A gradual intensification of the Sechenov effect in the first period of dynamic work may be accounted for by intensification of inhibition in nervous centers due to the increase of fatigue with further work. In case of a stronger fatigue the intensified inhibition acquires a more pronounced character at the expense of simultaneous negative induction appearing during the active rest.

#### LITERATURE CITED

- [1] N. K. Vershchagin, *Theory and Practice of Physical Culture*, \*\* 1952, vol. 15, issue 8, pp. 565-576.
- [2] N. K. Vereshchagin and V. V. Rozenblat, *Byull. Eksptl. Biol. i Med.*, 1952, vol. 33, No. 5, pp. 15-18.
- [3] N. K. Vereshchagin and V. V. Rozenblat, *Byull. Eksptl. Biol. i Med.*, 1952, vol. 34, No. 9, pp. 19-22.
- [4] S. I. Krapivintseva, *Byull. Eksptl. Biol. i Med.*, 1951, vol. 32, No. 8, pp. 105-109.
- [5] S. I. Krapivintseva, *Byull. Eksptl. Biol. i Med.*, 1951, vol. 32, No. 5, pp. 334-339.
- [6] S. P. Narikashvili and Sh. A. Chakhnashvili, *Theory and Practice of Physical Culture*, \*\* 1947, issue 7, pp. 317-325.
- [7] V. V. Rozenblat, *Theory and Practice of Physical Culture*, \*\* 1949, issue 10, pp. 733-740.
- [8] V. V. Rozenblat, *Byull. Eksptl. Biol. i Med.*, 1951, vol. 31, issue 6, pp. 400-404.
- [9] V. V. Rozenblat, *Byull. Eksptl. Biol. i Med.*, 1951, vol. 32, issue 5, pp. 339-344.
- [10] I. M. Sechenov, *Selected Works*, \*\* Moscow, 1953, p. 152.
- [11] I. M. Sechenov, *Autobiographical Notes*, \*\* Moscow, 1952, p. 281.
- [12] I. M. Trakhtenberg and I. V. Savitsky, *Byull. Eksptl. Biol. i Med.*, 1956, vol. 42, No. 8, pp. 12-15.
- [13] G. V. Folbort, *Zhur. Vysshei Nerv. Deyatel.*, 1951, vol. 1, issue 3, pp. 310-318.
- [14] G. V. Folbort, *Fiziol. Zhur. SSSR*, 1948, vol. 34, No. 2, pp. 157-164.
- [15] G. V. Folbort, in the book: *The Physiology of the Processes of Fatigue and Regeneration*, \*\* Kiev, 1951, pp. 7-28.

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\* The positive induction which arises in the center after the cessation of inhibition and preceding the renewal of the basic work, also has a certain role in the effect of increasing efficiency during active rest.

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\*\* In Russian.