ADDITIONAL DATA CONCERNING DEPRESSION OF THE α-RHYTHM AS THE ELECTROGRAPHIC MANIFESTIATION OF THE FUNDAMENTAL NERVOUS PROCESSES

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In their studies of the electrographic manifestation of conditioned reflexes in man, most workers have used depression of the α-rhythm as a criterion of the fundamental nervous processes [4-6, 8-10, 11, 13]. However, agreement has not been reached on the question of the nervous process to which this reaction corresponds.

In a previous paper [2] we examined certain facts which confirmed, to some extent, the view that depression of the α-rhythm in some cases accompanies the process of excitation and in others, inhibition [4, 12]. Further investigations have yielded additional evidence which is reported in the present communication.

EXPERIMENTAL METHOD

The technique of motor conditioned reflexes with preliminary verbal instruction was used. Photic stimuli (incandescence of a miniature 25 W lamp for 0.5 sec) in different positions in the field of vision were used as signals. The subject's motor reaction (pressure on a key) was recorded as the electromyogram (EMG), and recordings were also made of the latent period of the motor reaction with an electrical seconds counter, the EEG in the occipito-parietal regions of the right and left hemispheres, the pulse and respiration, a marker of the presentation of the signal, and markers of the analyzer and integrator. The recordings were made on an Alvar eight-channel electroencephalograph.

TABLE 1. Latent Period of Motor Reaction (in Milliseconds) (A), Time of Depression of α-Rhythm (in Seconds) of Left (B) and Right (C) Cerebral Hemispheres in Response to Positive Stimuli Presented with Different Pauses

Statistical criterion	Pause of 10 sec			Pause of 30 sec		
	A	B	C	A	B	C
M	0.354	0.94	0.995	0.44	1.54	1.63
σ	0.509	0.554	0.68	0.47	0.84	0.94
m (M)	0.108	0.118	0.152	0.1	0.183	0.214
t				2.0	2.7	2.4
t (in %) by Student's method				95	99	98

Three series of experiments were carried out. In the first the effect of a pause of varied duration (10 and 30 sec) between presentation of the signals was studied on the electrographic manifestation of positive and inhibitory conditioned reflexes. In the second series of experiments the effect of external inhibition on positive and inhibitory conditioned reflexes was investigated. An acoustic stimulus was applied 2-4 sec before the photic stimuli. In the third series of experiments the rearrangement of the order of presentation of the stimuli was studied. The following stereotype was first established: positive stimulus–inhibitory stimulus. The order of the stimuli was then altered: positive stimulus–positive–inhibitory stimulus (pause between stimuli 15 sec).

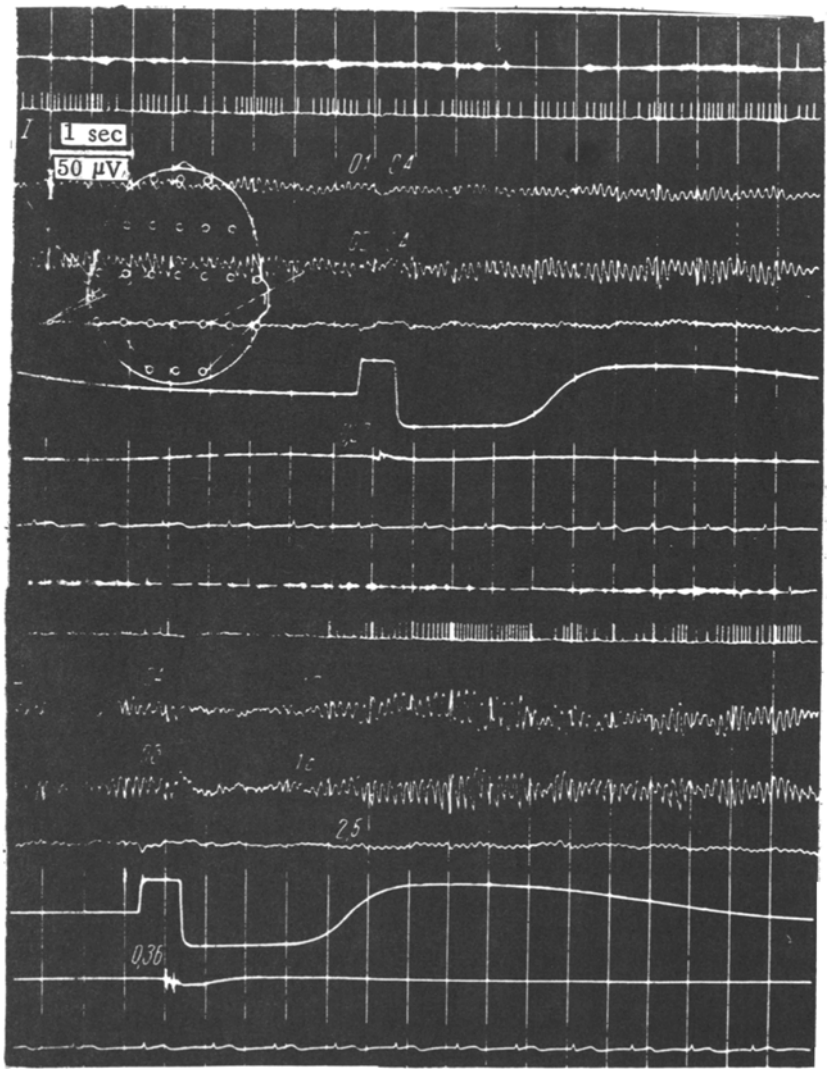

Fig. 1. Changes in EEG and latent period of motor reaction to a positive photic stimulus presented with pauses of (I) 10 sec and (II) 30 sec. Significance of curves (from above down): markers of working of analyzer and integrator; EEG; EEG; EEG; marker of photic stimulus; EMG and latent period of motor reaction; ECG.

TABLE 2. Time of Depression of α-Rhythm (in Seconds) of Left (B) and Right (C) Cerebral Hemispheres in Response to Inhibitory Stimuli Presented with Different Pauses

Statistical criterion	Pause of 10 sec		Pause of 30 sec	
	B	C	B	C
M	0.8	0.8	1.38	1.30
σ	0.151	0.151	0.38	0.33
m (M)	0.067	0.067	0.17	0.15
t			3.2	3.4
t (in %) by Student's method			98	98

The duration of depression of the α-rhythm was determined by measurement in millimeters and subsequent conversion into seconds. The results were analyzed by Student's method of variance analysis for small samples.

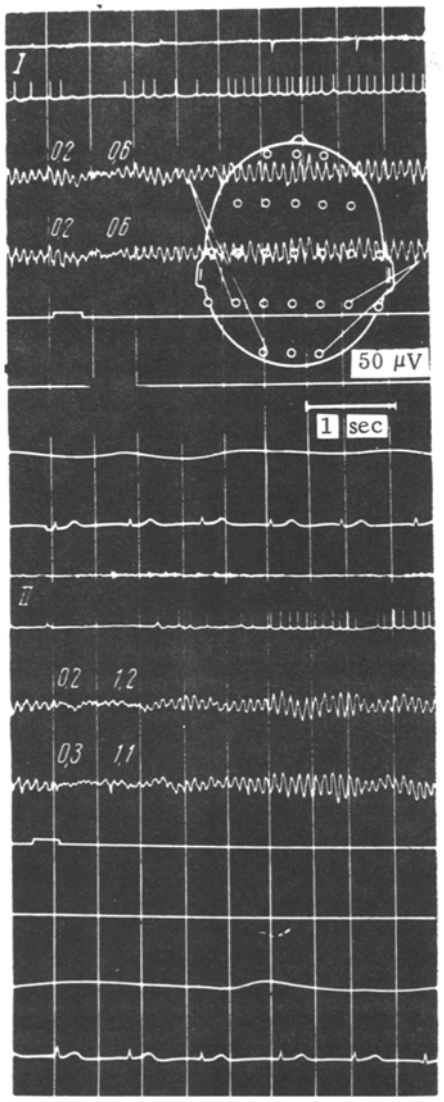

Fig. 2. Changes in EEG and latent period of motor reaction to an inhibitory photic stimulus presented with pauses of (I) 10 sec and (II) 30 sec. Significance of curves (from above down): markers of working of analyzer and integrator; EEG; EEG; marker of photic stimulus; EMG; respiration; ECG.

EXPERIMENTAL RESULTS

With a pause of 10 sec the latent period of the motor reaction and the duration of depression of the α-rhythm in response to a positive stimulus were shorter than with a pause of 30 sec (Fig. 1, Table 1). The duration of depression of the α-rhythm in response to inhibitory stimuli presented with a pause of 10 sec were shorter than with a pause of 30 sec (Fig. 2, Table 2).

As our previous investigations showed [3], external inhibition prolongs the latent period of the motor reaction and the phase of depression of the α-rhythm in response to photic stimuli. During repeated presentations of the bell, the orienting reaction to this stimulus was extinguished, as shown by shortening of the latent period of the motor reaction and shortening of the phase of depression of the α-rhythm in response to subsequent presentations of photic stimuli. Similar results were obtained by I. A. Peimer [6], who investigated the effect of external inhibition on a conditioned reflex formed in response to a vibrator.

External inhibition before a differential stimulus in certain cases disinhibited the motor reaction in man, but more often it prolonged the phase of depression of the α-rhythm in response to the differential stimulus (Fig. 3, Table 3).

After modification of the order of presentation of the stimuli the latent period of the motor reaction and the phase of depression of the α-rhythm in response to a positive stimulus are prolonged [5]. A change in order also prolonged the phase of depression of the α-rhythm in response to the inhibitory stimulus (Table 4).

The experimental results showed that an increase in the length of the pause between the stimuli, external inhibition, and a change in the order of presentation of the stimuli prolong not only the latent period of the motor reaction, reflecting the state of the cortical processes [1, 7], but also the phase of depression of the α-rhythm. Statistical analysis of the numerical results showed that the changes in the criteria examined either were significant or showed a well marked tendency. This indicates that the conditioned-reflex activity of the brain is accompanied by regular changes in electrical potentials. The change in the neurodynamic conditions leads to variations of the duration of depression of the α-rhythm, similar in direction in response to both positive and inhibitory stimuli, thus demonstrating a relationship between depression of the α-rhythm and the course and intensity of both nervous processes.

TABLE 3. Time of Depression of α-Rhythm of the Left (B) and Right (C) Cerebral Hemispheres in Response to Inhibitory Stimuli Before and After Application of External Inhibition

Statistical criterion	Before external inhibition		After external inhibition			
			2-4 sec		15 sec	
	B	C	B	C	B	C
M	0.7	0.8	1.6	1.8	0.8	0.9
σ	0.112	0.112	1.07	1.005	0.087	0.0612
m (M)	0.05	0.05	0.47	0.4	0.04	0.03
t			1.9	2.5	1.5	1.7
t (in %) by Student's method			90	95	82	86

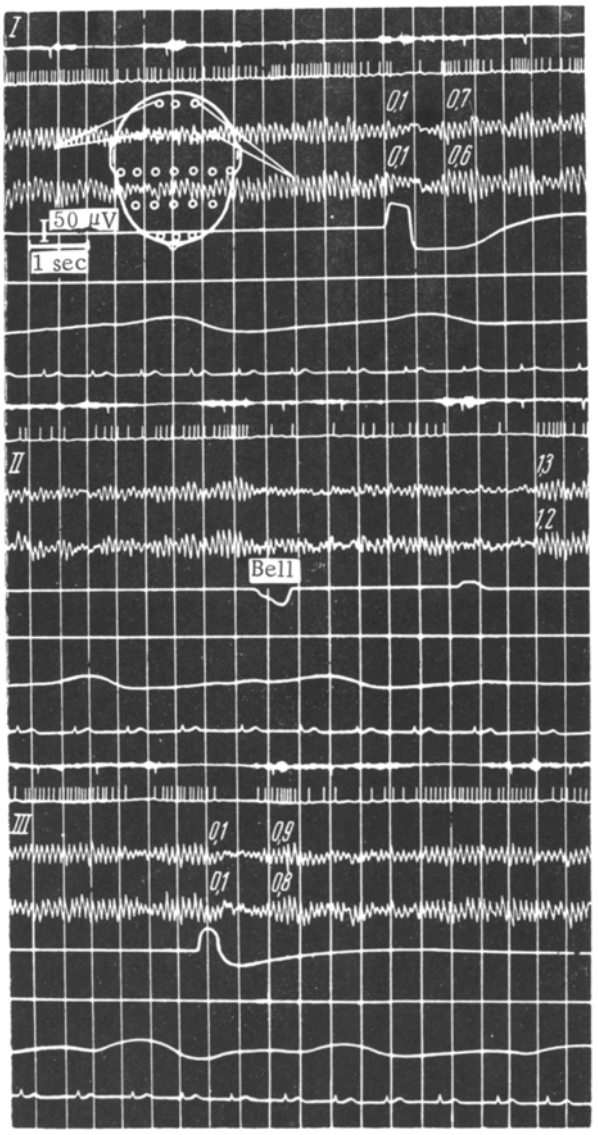

Fig. 3. Changes in EEG and latent period of motor reaction in response to inhibitory photic stimulus before presentation of external inhibition (I), and 3 sec (II) and 15 sec (III) thereafter. Significance of curves (from above down): markers of working of analyzer and integrator; EEG; EEG; markers of acoustic and photic stimuli; EMG; respiration; ECG.

TABLE 4. Time of Depression of α-Rhythm of the Left (B) and Right (C) Cerebral Hemispheres in Response to Inhibitory Stimuli Before and After a Change in the Order of Presentation of the Stimuli

Statistical criterion	Before change in order		After change in order	
	B	C	B	C
M	0.8	0.8	1.1	1.1
σ	0.224	1.58	0.194	0.194
m (M)	0.1	0.07	0.08	0.08
t			2.3	2.8
t (in %) by Student's method			95	97

SUMMARY

This work describes the results of a study of an electrographic manifestation of inhibitory and positive conditioned reflexes in man in response to photic stimuli, differing by localization in the visual field.

The duration of the α-rhythm depression in respose both to positive and differential signals changes relative to changes in neurodynamic conditions. On this basis the author favors the view that depression of the α-rhythm may accompany both excitatory and the inhibitory processes.

LITERATURE CITED

1. E. I. Boiko, In Book: Borderline Problems of Psychology and Physiology [in Russian], p. 7, Moscow (1961).
2. M. P. Ivanova, Byull. éksper. biol., 2, 27 (1962).
3. M. P. Ivanova, Zh. vyssh. nervn. deyat., 1, 42 (1963).
4. A. B. Kogan, Fiziol. zh. SSSR, 9, 810 (1958).
5. N. A. Mushkina, Electrophysiological study of cerebral processes during the formation of temporary connection in man. Author's abstract of candidate dissertation. Leningrad (1954).
6. I. A. Peimer, In Book: Problems in Electrophysiology and Encephalography [in Russian], p. 70, Moscow-Leningrad (1960).
7. A. I. Roitbak and Ts. M. Dedabrishvili, In Book: Problems in the Physiology of Sport [in Russian], p. 139, Moscow (1958).
8. V. S. Rusinov, Fiziol. zh. SSSR, 11, 1356 (1960).
9. E. N. Sokolov, Perception and the Conditioned Reflex [in Russian], Moscow (1958).
10. G. Durup and A. Fessard, Ann. psychol., Vol. 36, p. 1 (1935).
11. A. Gastaud, A. Roger, S. Dongier, et al., Zh. vyssh. nervn. deyat., 2, 185 (1957).
12. H. H. Jaspar, C. Ricci, and B. Down, In Book: Electroencephalographic Investigation of Higher Nervous Activity [in Russian], p. 129, Mosocw (1962).
13. K. Motokawa and B. Huzimori, Tokyo, J. exp. Med., Vol. 50, p. 215 (1949).

All abbreviations of periodicals in the above bibliography are letter-by-letter transliterations of the abbreviations as given in the original Russian journal. *Some or all of this periodical literature may well be available in English translation.* A complete list of the cover-to-cover English translations appears at the back of this issue.