DEPRESSION OF THE α-RHYTHM AS AN INDICATION OF UNDERLYING NERVOUS PROCESSES

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Animal and human studies have shown that conditioned reflex activity is accompanied by variations of the electrical cerebral potentials [2, 3, 4, 7, 9, 11, 12]. At present, entirely contradictory opinions prevail concerning the electroencephalographic expressions of excitation and inhibition. Thus, in recent years the view has become widely held that depression of the α-rhythm represents an arousal response, and corresponds to the development of excitatory processes [1, 5, 8, 9, 10, 13, 14 and others]. There has also been an alternative view that a depression of the α-rhythm represents merely the desynchronization of cortical neurones, an effect which might result either from excitation or from inhibition [2].

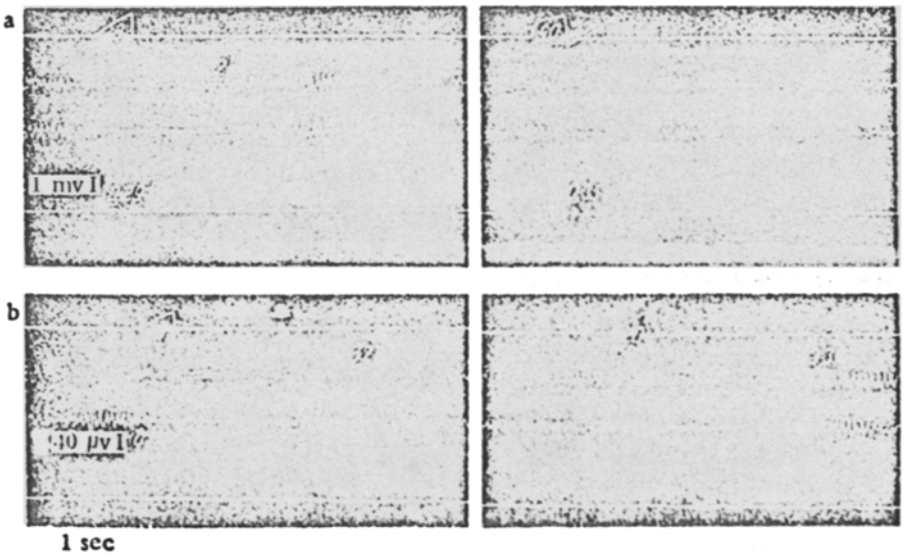

Fig. 1. Change of the electroencaphalogram after repeatedly presented light signals: (a) at the 3rd and 40th positive signal; (b) at the 8th and 20th negative signal. First line – signal marker; second and third lines – electroencephalogram from the occipito-parietal region of the right and left cerebral hemisphere; fourth line – electromyogram.

In the present work we have set out to collect some further facts to determine what process underlies depression of the α-rhythm.

METHOD

We have used the method of the motor conditioned reflexes combined with previous verbal instructions. The signals were light stimuli (lighting a 25 w lamp for 0.5 seconds), and they differed from each other in their position in the field of view. Records were made of the electromyogram of the responses of the subject, who pressed a key, and an electrical chronograph was used to record the latent period; the electroencephalogram was taken from the occipital and parietal regions of the left and right cerebral hemispheres, and a signal marker was also recorded. We carried out 40 experiments.

RESULTS

The experiments showed that in response to both positive and inhibitory signals, a secondary generalized response occurred, and took the form of a depression of the α- and an increase of the β-rhythm. Analysis of the electroencephalograms recorded either a number of times on a single day (29-70 positive and 5-32 inhibitory signals), or on different days showed that depression of the α-rhythm, including after-inhibition, was very stably preserved when differentiation had been established, and was not extinguished (Fig. 1).

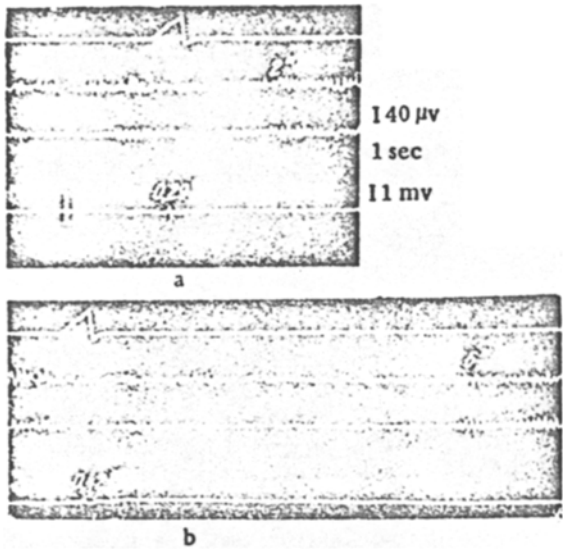

Fig. 2. Change of the electroencephalogram in response to a positive stimulus (a) the single presentation (b) with differentiation. Indications as in Fig. 1.

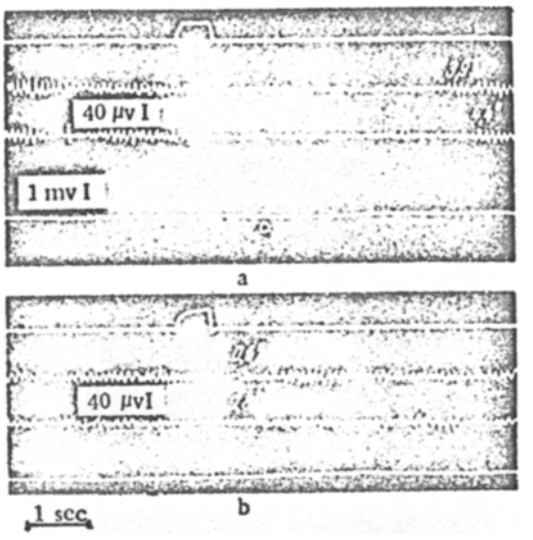

Fig. 3. Change of the electroencephalogram in response to an inhibitory stimulus with differentiation (a) of 3 and (b) of 2 stimuli. Indications as in Fig. 1.

The maintained depression of the α-rhythm by both positive and inhibitory stimuli, when they were endowed with the significance of a signal, apparently indicated that this electroencephalographical response cannot be associated merely with excitation or inhibition of cortical neurones. Possibly it represents some intermediate cortical activity whose consequence may in one case be excitation and in others inhibition [2].

TABLE 1. Value of the Latent Period of the Motor Response (a) and of the Duration of the Depression of the α-Rhythm of the Left (b) and of the Right (c) Parieto-Occipital Region Induced by a Positive Light Stimulus (in seconds)

Subject	Stimulus alone			Stimulus with differentiation		
	a	b	c	a	b	c
1	0,62	0,7	0,6	1,28	1,5	1,4
2	0,92	1,2	1,4	1,72	2,0	2,1
3	0,59	1,2	1,4	1,26	2,0	1,9
4	0,30	1,3	1,3	0,65	2,6	2,6
5	0,38	1,4	1,2	0,71	1,8	1,5
6	0,34	0,7	0,6	0,52	2,0	1,9
7	0,32	0,6	0,6	0,60	1,4	1,2
8	0,31	0,8	0,9	0,63	1,4	1,8
9	0,33	0,6	0,7	0,67	1,2	1,0
10	0,32	0,7	0,6	0,70	1,0	0,9

TABLE 2. Duration of Depression of the α-Rhythm (b) of the Left and (c) of the Right Hemisphere of the Parieto-Occipital Region in Response to an Inhibitory Light Signal with Differentiation of 2 and of 3 Stimuli

Subject	Two stimuli		Three stimuli	
	b	c	b	c
1	0,9	0,9	1,1	1,4
2	0,9	0,7	1,2	1,0
3	0,6	0,7	1,0	0,9
4	0,7	0,6	1,2	0,8
5	0,6	0,7	1,2	1,0
6	0,4	0,5	0,8	1,0
7	1,9	1,8	3,4	3,3
8	1,0	0,7	2,1	2,3
9	1,3	1,0	2,1	2,3
10	1,0	1,0	1,4	1,3

A comparison of the duration of the depression of the α-rhythm to one and the same positive stimulus under different neurodynamic conditions showed that it was variable: when the positive signal alone was presented the depression was shorter than when there was differentiation. It should be noted that the latent period of the motor response was also prolonged when there was differentiation (Fig. 2 and Table 1).

When the inhibitory signal was shown together with a single positive signal ("simple" differentiation), the duration of the depressed phase of the α-rhythm was shorter than it was when the inhibitory signal was presented together with two positive stimuli ("complex" differentiation) (Fig. 3 and Table 2).

Changes in the duration of the depression due to complication of the nervous connections, and the common direction of the variations in the latent period of the motor response, which reflects the condition of the cortical processes [6] indicate a common relationship of the different cortical phenomena, in particular a dependence of the duration of the depression on the course and direction of the excitatory and inhibitory processes.

SUMMARY

A study was made of the changes of cerebral electrical activity in connection with the elaboration of motor conditioned reflexes in man. It was shown that secondary generalized reactions of the cortical rhythms, manifested as a depression of the α-rhythms, occurred under the influence of both positive and inhibitory stimuli. In complex differentiation between a positive and an inhibitory signal the response was more prolonged than it was with simple differentiation.

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