THE INITIAL ELECTRONIC COMPONENT OF THE EVOKED POTENTIAL

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The latent period of the initial potentials in the optic cortex associated with the arrival of an afferent volley is composed of the retinal time, the time for conduction of the impulses along the fibers of the optic tract and radiation, and the time of synaptic transmission in the relay nucleus of the thalamus, and it is 1-3 msec longer than the latent period of the responses in the chiasma and optic tract. The organization of the optic system appears to exclude the possibility that earlier components of the evoked potential could appear in the cortex. However, assuming that intercentral connections not only are formed by impulses, but may also be electrotonic in character [7], this possibility becomes real. It has been reported that a central electrotonic action is seen earlier on an effector apparatus than a reflex response arises in the form of an action potential [6].

The object of the present investigation was to detect components of this type preceding evoked potentials in the optic cortex.

EXPERIMENTAL METHOD

Experiments were carried out on ten rabbits. The stimuli consisted of single flashes from a flash bulb (50 μsec, 0.3 J), applied at intervals of 10 sec. The potentials were recorded extradurally on an ac amplifier with a transmission band of 1-1000 cps. Monopolar leads were used, and the reference electrode was placed in the region of the occipital protuberance.

EXPERIMENTAL RESULTS

In 40% of the experiments after photic stimulation the waves of the background rhythm on the superposed curves appeared to move closer together at the beginning of the primary response (Fig. 1A). Sometimes there were two (Fig. 1B) or several levels of convergence. After repeated superposition of the curves, the convergence as a rule was less clear or absent altogether.

In four rabbits with marked convergence, the changes in the width of the superposed curves were estimated (Fig. 2). At the moment of photic stimulation, no significant changes took place in the width of the superpositions, for the probability of the changes, determined by Student's method, was not significant and was given by $P_{1-2} = 0.7$. At the same time, the convergence of the superposed curves at the beginning of the primary response was statistically significant ($P_{2-3} = 0.02$). Results showing the qualitative changes in the width of the superposed curves from the recordings of the background activity (20 msec after arbitrarily chosen times) and the changes 20 msec after the photic stimulation are given in the table. The number of cases of convergence and of absence of changes in the range of scatter of the waves of background activity remained practically unchanged ($P_{1-2} = 0.7$; $P_{1-3} = 0.9$). After photic stimulation, the number of cases of convergence of the superposed curves rose by 18%, which is statistically significant ($P = 0.05$). Analysis within the limits of the lower series also revealed significant differences between the results obtained ($P_{1-2} = 0.01$; $P_{1-3} = 0.001$).

Hence, photic stimulation affected the development of the waves of the background rhythm and led to the apparent stabilization of their level before the beginning of the primary response. However, the results presented above can be regarded only as indirect evidence of the possible deformation of the waves of background activity, because no criteria are available by which the further course of each wave could be predicted had no photic stimulus been applied.

As a model of the background wave on which it would be possible to make direct observations on the initial changes associated with photic stimulation, a sufficiently constant negative slow wave of the evoked potential was

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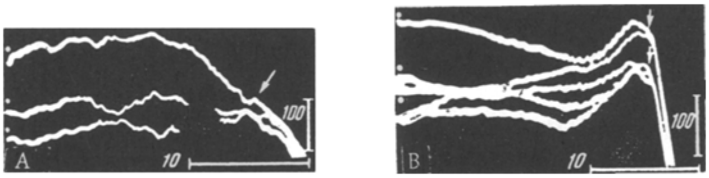

Fig. 1. Convergence of superposed curves in the interval between photic stimulation and the primary response: A) chronic experiment; B) acute. Immobilization with diplacin. Photic stimuli marked by dots, and the beginning of the primary responses by arrows. Deflection of the beam upward corresponds to negativity beneath the active electrode. Calibration: time, msec, amplitude, μV.

Character of Changes in Width of Superposed Curves

Character of tracing	Convergence (1)		No change (2)		Divergence (3)	
	No. of cases %	m_p	No. of cases %	m_p	No. of cases %	m_p
Background activity	32	5.8	35	6.1	33	6.0
After photic stimulation	50	6.2	35	5.9	15	4.4

m_p — mean error.

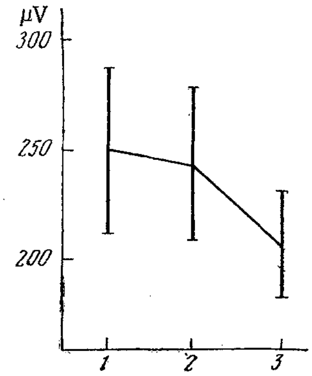

Fig. 2. Width of superposed curves at various moments of time relative to photic stimulation: 1) 20 msec before photic stimulation; 2) at the time of photic stimulation; 3) before the beginning of the primary response. The vertical lines through the curve correspond to the magnitudes of the standard deviations.

chosen. Two evoked potentials arising in response to a single (1) and a paired (2) photic stimulus, and the scheme of superposition of these responses are shown in Fig. 3A. The ascending parts of the slow wave in both responses completely coincided. However, deformation was observed in the development of the slow wave in the interval between the second photic stimulus and the beginning of the primary response.

The superposition of the undistorted and the deformed slow waves recorded in another experiment with a higher winding speed is illustrated in Fig. 3B. The recordings were made so that only the apex of the slow wave arising in response to a single photic stimulus (1) and the apex of the analogous slow wave (2) deformed after the second photic stimulus were thrown on the frame. The latent period of the first signs of deformation of the slow wave was 8-12 msec.

The presence of several levels of convergence of the superposed curves and also the relative infrequency of this phenomenon may be attributed to the complex character of the background rhythm of the EEG. The waves of potential recorded by superficial electrodes are the sum of at least two types of activity, one of which reflects the local changes of potential associated with excitation of local groups of cortical neurons, while the other reflects changes associated with more generalized fluctuations of potential [1, 3, 9]. The distortion of the slow negative wave of the evoked potential under the influence of afferent stimulation suggests that this process is one of damping of local dendritic activity. In these circumstances, the waves of potential associated with the generalized activity, and also the slow changes in the stable cortical potential, will lead to an apparent change in the levels of stabilization of the dendritic potentials.

Stabilization of the level of the potential at the beginning of the primary response may be compared with the active inhibition of the spontaneous rhythmic activity of the optic tract during development of the *a* wave in the electroretinogram [8, 11]. The obliteration of the traces from previous stimuli provides more nearly optimal conditions for the analysis of the information brought by the afferent volley.

In addition to the above, when such influences reach the projection areas of the cortex they may activate the corticofugal systems of the analyzers [4, 5, 12], as a result of which the specific projection pathway becomes "tuned" to receive the appropriate volley of afferent impulses.

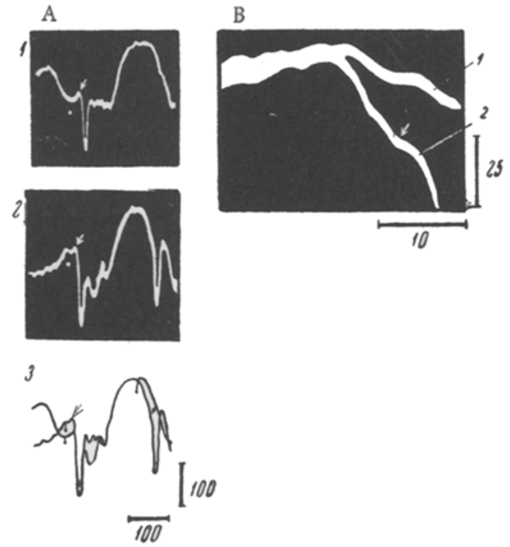

Fig. 3. Detection of the initial component of the evoked potential during paired stimulation. A) Deformation of the negative slow wave of the evoked potential after a second photic stimulus; 1) response of optic cortex to a single stimulus; 2) to a paired stimulus; 3) scheme of superposition of the two responses; B) superposition of the two responses at a higher winding speed: 1) response of the optic cortex to a single stimulus; 2) to a paired stimulus. The beginning of the higher winding speed corresponds to the moment of the second photic stimulation.

Only suggestions can be made regarding the mechanisms of stabilization of the dendritic potentials of the cortex. According to the morphological evidence [2], a direct pathway exists from the retina to the cerebral cortex. It may be suggested that influences stabilizing the dendritic potential of the cortex are transmitted along these fibers. However, these influences can hardly be of the nature of impulses, because the latent period of the beginning of deformation of the potential before the primary response is practically equal to the retinal time. It is a more probable assumption that they are electrotonic in character as a result of the spread of currents generated by postsynaptic changes, through a three-dimensional conductor, to remote parts of the neurons terminating in the cortex, the ganglionic cells of the retina, for example. As already mentioned, during the development of the *a* wave in the electroretinogram, which arises shortly before the deformation of the dendritic potentials or coincides with it, the background activity of the optic tract is blocked. This suggests that during the *a* wave definite changes take place in the functional state of the ganglionic cells, which may be transmitted electrotonically along their axons to the cerebral cortex. According to Freeman [10], such electrotonic influences may act on the surrounding neutrons.

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