INTERHEMISPHERIC INTERACTION AFTER UNILATERAL INJURY TO THE CEREBRAL CORTEX

V. P. Dobrynin, Z. F. Zvereva,
E. N. Pogozheva, and A. N. Sovetov

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In the last decade new facts characterizing the morphological and functional cortical organization of projection and association systems have been obtained in the course of experimental and clinical observations and these have contributed to our understanding of the mechanisms of the reliability of brain activity [1-3, 8]. However, pathways of restoration of disturbed functions still remain largely unexplained. The study of these problems, moreover, is of considerable theoretical and practical urgency.

The object of this investigation was to study the dynamics of interhemispheric relations after unilateral injury to somatic or visual cortical pathways. Attention was concentrated on the characteristics of the functional state of the symmetrically opposite zones to the injury and the cortical association (parietal) areas.

It was considered, on the basis of results of previous investigations in the writers' laboratory [6] and of data in the literature [4, 7], that disturbed CNS function can be restored as a result of increased functional activity of zones symmetrically opposite to the region of injury. It was also borne in mind that the parietal association areas, which are polymodal formations, can also take over (to some extent) the disturbed functions of the specific cortical projection zones.

EXPERIMENTAL METHOD

Acute experiments were carried out on cats anesthetized with pentobarbital (40 mg/kg) and unanesthetized cats immobilized with listhenon. The evoked potential to photic stimulation was recorded in the visual and association areas of the cortex. The parameters of the flashes were: duration 100 μsec, energy 0.3 J, repetition frequency 0.2 Hz. The animal's eyes were atropinized. The somatosensory cortex was reversibly blocked by application of ice, made from physiological saline, to the cortex. Measures were taken to prevent the water formed by thawing of the ice to spread over adjacent areas of the neocortex (the cooled region was sealed off from the adjacent region by a barrier of cotton soaked in mineral oil). Throughout the period of cooling (30 min) the region of application of the ice was thoroughly dried. The techniques used by A. G. Polyakova, in which the temperature in the intact parts of the brain was monitored, were used in this investigation. Experiments were carried out on 27 cats weighing 3.5-4.5 kg.

EXPERIMENTAL RESULTS

After unilateral reversible blocking of somatosensory area S1 different changes were observed in evoked potentials in the parietal association cortex of the cooled and intact hemispheres. On the side opposite to the region of cooling, during the initial period of application of ice to the cortex, lasting 2-5 min (Fig. 1a, b, c), a reduction in amplitude of all phases of the evoked response was observed, whereas after 17-25 min of cooling (Fig. 1d, e) a marked increase in amplitude of the early component of the evoked potential was recorded. The configuration of the evoked responses was fully restored to its initial pattern 50-60 min after the end of application of ice (Fig. 1f). Recording electrical activity in

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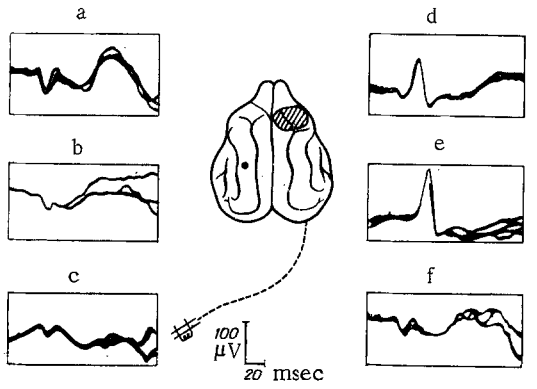

Fig. 1. Evoked potentials in association area of cortex before cooling somatosensory area (a), at different stages of cooling (b, c, d, e), and after removal of the ice (f).

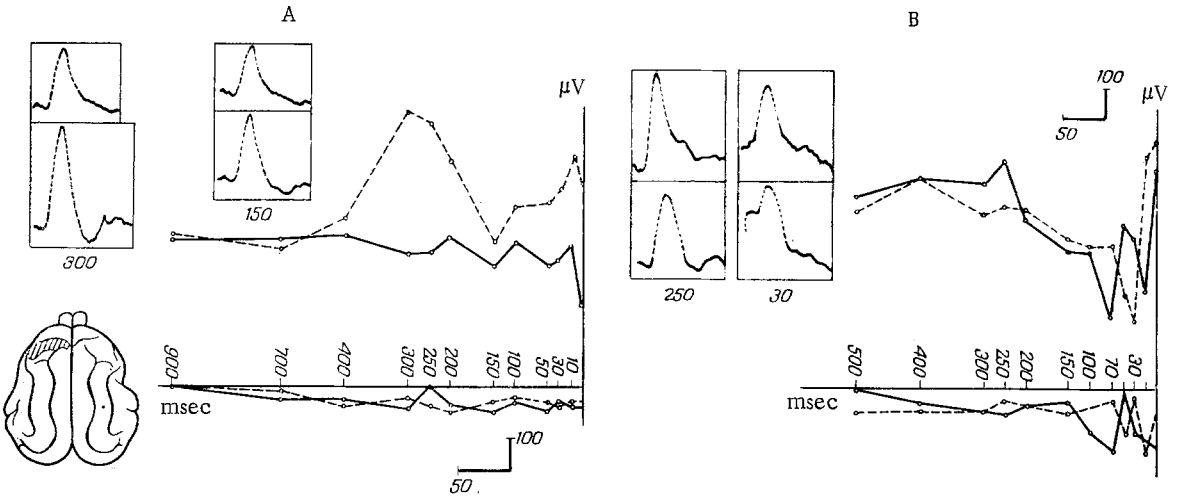

Fig. 2. State of bioelectrical responses in association cortex before (continuous line) and after (broken line) extirpation of somatosensory areas (S1 and S2). Abscissa, duration of interstimulus intervals (in msec); ordinate, averaged amplitudes of positive and negative phases of responses (in μV). A) Transcallosal testing stimulus, B) somatosensory testing stimulus.

the parietal association cortex on the side of cooling revealed only the stage of a decrease in amplitude of the evoked potentials, without any subsequent increase.

To study the finer details of interhemispheric interaction a series of experiments was carried out with paired stimulation. If a transcallosal stimulus was used as the conditioning stimulus, after removal of somatosensory area S1 the response to the testing visual stimulus in the association area was found to be considerably altered. The amplitude of the negative phase of the response was increased by 1.5-2 times, a second positive wave appeared, and so on (Fig. 2A). Experiments in which a somatic (and not transcallosal) stimulus was used as the conditioning stimulus served as special controls. These investigations revealed only very slight changes in the configuration of the test-evoked potential to light, evidence that transcallosal stimulation is a more effective means of modifying the functional state of homologous cortical areas (Fig. 2B).

The next series of experiments was devoted to the study of the functional state of cortical areas symmetrically opposite to those extirpated. The results of these experiments showed that in this case considerable activation of electrical responses took place in them, as shown by an increase in amplitude of both primary and secondary phases of the response (Fig. 3). The investigations thus showed that after injury to the brain interhemispheric interaction exhibits certain special features, expressed as enhanced functional activity in areas of the cortex symmetrically opposite to the injury, and also in parietal association areas.

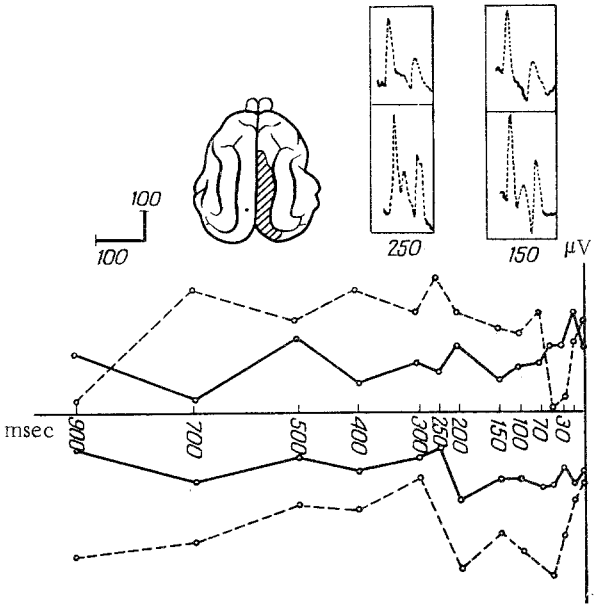

Fig. 3. State of responses in visual area of left hemisphere (area 17) before and after extirpation of symmetrical visual area of opposite hemisphere. Legend as in Fig. 2.

Through transcallosal stimulation it is possible to modify to some degree the functional state of the areas of the brain studied in this investigation; in the long run this can be regarded as a possible method of development of compensatory and restorative processes in the CNS.

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