perimental pneumococcus peritonitis in rats is of 2-4 days' duration, a time which is adequate for the development of orally stimulated immunity in control rats, the infection proceeds to a fatal termination in spite of the immediate institution of this treatment. The survival of 2 rats out of the 60 animals used in these experiments is to be attributed to individual differences in the rats; this factor of variation ordinarily appears in such experiments to an even greater extent than in this case. The immune response in already infected rats apparently is inhibited so that oral immunization is ineffective as a therapeutic agent under these conditions in these animals.

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Cerebral Action Potentials.*

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The following observations, some confirmatory, based on experiments on 8 cats and 2 monkeys, were made during an exploration of the cerebral cortex and underlying structures for spontaneous and evoked activity. Anatomical relations given are only approximate; the work is being continued with the aid of a Horsley-Clark stereotaxic instrument. Action potentials picked up by an Adrian-Bronk electrode, amplified, and fed into a loud speaker and high-voltage cathode ray oscillograph, were the index of activity. Numerous controls have convinced us that extraneous pick-up did not confuse true action potentials in the phenomena described. For example, during penetrating movement of the needle of less than 1 mm. there appeared successively: nothing, strong auditory responses, nothing, strong optic responses, nothing. Clearly, responses may be highly localized, and a non-specific spread is excluded.

Auditory responses were obtained from the temporal cortical surface, projection tracts, auditory thalamus, and lower structures in the monkey, from all but cortex in the cat. With the electrodes on a large tract, responses were obtained to stimuli near the human threshold. Different sounds (*e. g.*, watch tick and voice) and pitches are recorded most strongly at different needle positions, indicating a spatial separation of impulses set up by different pitches. Similarly, a fairly sharp di-, tri- or polyphasic wave appears on the

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oscillograph for each watch tick. The form differs from R. to L. ear for one needle position, and for one ear at different needle positions.

Considerable discharge was usually present in the pathways even without deliberate sound stimulation. In the monkey, a stimulus at 660 d.v. gave a standing wave of the same frequency on leading from auditory tracts, a completely asynchronous discharge, stronger at the start, from the cortical surface. In the cat and monkey, melodies could usually be recognized on leading from auditory tracts, although words were garbled.

Optic responses were obtained from the cortical surface, radiations, optic thalamus and tracts in the monkey and cat. (One experiment from the frog's optic lobe.) Responses to slight finger movements several inches from the eyes were obtained in diffuse daylight, sensitivity being greatest in dark-adapted eyes. Tracts gave maximum responses usually at on and off, though sometimes asynchronous or even partially synchronized discharges continued undiminished during the entire light period. A marked after-discharge was often present, sometimes as long as 5 seconds. Cortical responses were entirely asynchronous.

In the cat, a very large cortical area yielded responses, best in the occipital pole, falling off slowly anteriorly, more rapidly laterally, but detectable well into the frontal region. Localization appeared sharper in the monkey, both as to total optic area and definition of the margin. The response diminished, often to zero, as the electrode penetrated the cortex, then increased to a maximum intensity at 3-4 mm. depth in the cat, 7 mm. in the monkey. Responses from these underlying tracts were distinctly sharper (more synchronous) than from the superjacent cortex. Bilateral responses were the rule. In several instances optic and auditory responses were obtained from the same electrode position, and in such cases the response to a regular auditory stimulus seemed to be increased when a light was flashed into the eyes.

Somaesthetic responses were obtained from the post-central gyrus of the monkey and showed the anticipated localization. Thus, gentle stroking of the hair of each limb in turn gave a response in the medial portion of the gyrus only from the crossed leg, in the lateral portion only from the crossed arm. Presumable proprioceptive stimulation by gently flexing the toes gave responses in the foot region of the pre-central gyrus. A more intense continued activity was obtained from the post-central than the pre-central gyrus.

"Spontaneous" activity was regularly obtained in the absence of

deliberate stimulation, varying from a continuous background through waves to sharp peaks. Though some of these potentials were surely evoked by unidentified afferent impulses, others probably represent (spontaneously) changing cell potentials. They were often well localized, intense, relatively slow in frequency and duration of each wave, and were reversibly and fairly continuously depressed by ether. Evoked activities, such as optic and auditory, showed little change as ether was pushed, until they sharply disappeared; and returned in the same way. The slow potential waves, on the contrary, failed and returned gradually, changing both amplitude and frequency, and light narcosis led to augmentation rather than depression. In several cases the "spontaneous" activity suddenly increased (needle not moved), to be followed in a few seconds by general struggling. Pure CO_2 inhalation reversibly depressed activity to zero, after an early increase.

Rhythmic discharges were obtained, mainly from thalamic and hypo-thalamic regions, but also (and especially in the monkey) from frontal and occipital lobes. (Large semirhythmic waves were obtained from the cerebellum.) These varied from slow waves, almost of sine shape with "overtones", at 40-80 a second and standing on the oscillograph, to sharp, short, diphasic spikes, varying from 10 to 100 per second and of regular frequency. Intense high frequency (1000 or more) semi musical "howls" were given by basal regions. Many of these rhythmic discharges waxed and waned in intensity over intervals of a few seconds to 3 minutes, probably as individual units became more or less synchronized. In one case, light in the contralateral eye inhibited a strong, continuous discharge. Discharges were obtained from the hypo-thalamic region synchronous with the heart beat and with respiration. Traction on the liver produced long lasting activity in the same vicinity. Though it is impossible to describe these various rhythmic discharges, many possess a distinct individuality and can be recognized easily over the loud speaker, distinguished sharply from one another, and identified from animal to animal.

It is interesting that animals under avertin anesthesia, presumably entirely unconscious and yielding no reflex response to painful stimulation of the legs, no knee jerk and but a slight pupillary reflex to light, should still give marked electrical responses to these same stimuli from the cortex itself. The question of the relation of neural activity to conscious states is thus brought into focus.