FUNCTIONAL CHARACTERISTICS OF SINGLE NEURONS
IN PIGEON CORTEX

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Cerebral reactions to photic and acoustic stimuli have been studied in birds from recordings of potentials in
generalized form (electroencephalograms, electrocorticograms, evoked potentials) [1, 8, 10, and others]. It is still
not known how cortical neurons in birds react to other forms of stimulation (tactile, proprioceptive, etc.), and
whether response reactions to these different forms of stimulation are produced by different or by the same neurons.

As the solution of these problems is important for an understanding of the functional structure of the cortex
from both evolutionary and ecological standpoints, an attempt was now made to examine the detailed arrangement
of receptor fields and the connections which individual neurons in the pigeon cortex have with different systems.

METHOD

The experiments were carried out on 28 adult pigeons, in which 106 neurons situated in different parts of the
cortex at depths of not more than 1 mm in the medial regions and 0.3-0.6 mm in the lateral regions were examined.

The skull was trephined under local anesthesia. After removal of the dura mater, an annular silver electrode
was placed in the trephine opening, which was 2-3 mm in diameter, for the recording of electrocorticograms, re-
quired for continuous observation of the functional state of the cortex. The indifferent electrode was attached to
the skin in the midline of the frons. Flaxedil or Listenen was injected and artificial respiration instituted.

The spike potentials of single neurons were recorded from within the cell by means of a wolfram microelec-
trode, the external diameter of the glass-insulated tip being 1-4 μ. A hydraulically operated micromanipulator was
used to insert the microelectrodes. The cathode follower used has been described previously [4]. The electrical
phenomena were recorded on cinefilm from the oscillograph screen. During an experiment continuous analysis and
recording of changes from moment to moment in the impulse rates were maintained, so that the nature and degree
of change in background activity could be followed exactly, and receptor field could be quickly discovered and
outlined. This record was produced by an electronic ink-writing potentiometer with an integrator [4].

The photic stimulation employed was diffuse illumination of the eyes (300 lux); the acoustic stimulus was a
tone of 2000 c/s; tactile stimulation was produced by touching and moving the feathers with a fine brush; and
movement of wing, leg, or tail provided proprioceptive stimulation. The pigeon was in a heated atmosphere through-
out the experiment, and its body temperature was maintained between 38 and 40°C.

RESULTS

The background activity of the cortical neurons examined varied in rate from 1 to 35 impulses per sec
(11.6 ± 1.7), but the rate was generally about 10 impulses per sec. In most cases background activity took the form
of single spike potentials, occurring at more or less regular intervals in some, but irregularly in other cases. Less
frequently the activity was in the form of rapid bundles and groups of spike potentials (Fig. 1, a-c). Mixed forms
were also observed (Fig. 1, b). In practically no case could the spike activity be correlated with the slow waves in
Fig. 1. Types of background activity observed in individual neurons of pigeon cortex (upper tracings). a) Continuous impulsion in form of single spikes; b) mixed type of impulse activity — single and grouped spikes; c) series of spike potentials; d) same type as in c, but impulse activity only seen in association with large waves in electrocorticogram. Lower tracings) superficial electrocorticograms. Scale for microelectrode channel) 5 mV; and for electrocorticogram) 100 μV. Time scale) 1 sec. In c, ECG is superimposed on electrocorticogram.

The background activity of neurons in the pigeon cortex is thus similar to that of cortical cells in other warm-blooded animals (cat, rabbit, guinea-pig, rat, etc.) [5, 14, 16, 20, 21, and others].

With natural forms of stimulation (photic, acoustic, tactile, etc.) the neuronal reactions manifested themselves either as fast bundles of spike potentials or in the form of more numerous impulses generally, with shorter intervals; inhibition was seen as slowing or, it might be, complete suppression of activity. In the latter case it was difficult to determine latent periods. Reactions in the form of parcels of impulses were seen with photic and acoustic stimuli, while the second type of reaction was generally associated with tactile and proprioceptive forms of stimulation, particularly the latter.