Bishop and Beale (*9*) working with variety 1 of *P. aurelia*, have reported different electrophoretic mobilities on starch gel for three different isolated antigens, G, D, and T.

The differences in immunological relationships, ammonium sulfate solubilities, and isoelectric points suggest that the antigens differ in their amino acid sequence. However, the possibility that the variations result only from differences in the gross pattern of folding cannot be ruled out. Studies designed to settle this point are now being undertaken. It is hoped that light will be shed on the general problem of the genetic control of protein specificity (*10*).

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10. This work was aided by grants to J. R. Preer from the Phi Beta Psi sorority. I wish to acknowledge the support of J. R. Preer, and the assistance of S. D. Rodenberg in connection with certain of the technical procedures.

20 February 1961

Excitation and Inhibition of Neuronal Firing in Visual Cortex by Reticular Stimulation

Abstract. The frequency of action potentials of about one-third of the neurons sampled in the striate cortex of awake rabbits was clearly modified by mild stimulation of the reticular core of the brain stem. Reticular stimulation often brought about enhancement of firing in units activated by light, while it usually had the contrary effect upon light-inhibited units.

A behavioral study (*1*) has demonstrated that the threshold of tachistoscopic discrimination can be lowered by electrostimulation of the brain-stem tegmentum, thus indicating that reticular activation facilitates some central process of vision. The purpose of the present investigation (*2*) was to study how reticular activation affects single neurons in the visual cortex. In acute experiments, these cells have already been shown to be influenced by stimulation of diffuse projection nuclei of the thalamus (*3*). However, the use of chronic animals is more desirable for such investigations than the use of any kind of acute preparation, in which lesion of tissues or the action of some drug may obscure effects attributable to the experimental variables.

The experiments were performed on New Zealand white rabbits. Steel microelectrodes, made according to Green's technique (*4*), were utilized for recording action potentials of single units. Each animal was surgically prepared under anesthesia, at least 1 day before any experiment. A tubular steel implant, fitting in a trephine hole in the skull, was cemented to the bone after the underlying dura had been removed. Two electrodes for stimulation were introduced through another hole and implanted in the mesencephalic tegmentum. The skin was sutured around the electrode leads and the metal implant. The lumen of the latter was filled with warm mineral oil and sealed with a threaded cap.

For an experimental session the animal was put in a hammock, and the mineral oil in the implant was replaced by a 4-percent solution of agar at 40°C which solidifies at body temperature, thus eliminating respiratory movements of the brain. To drive a microelectrode for recording, a special hydraulic micropositioner, resembling in some features the one developed by Hubel (*5*), was used (Fig. 1). A hollow adapter, screwed to the implant, is the base to which a nylon cylinder is fastened. The microelectrode is set in the center of a nylon piston riding inside and is electrically coupled to the input of an amplifying system through a cathode follower. A vent in the side of the adapter maintains the space between piston and agar at atmospheric pressure, while the cylinder is filled with oil above the piston and connected to a micrometer-syringe by polyethylene tubing. When the syringe is advanced, the microelectrode tip traverses the agar and penetrates the cortex. The preparation permits repeated punctures in each animal for a number of days.

Diffuse binocular light was used (about 1070 lux at the corneas), lasting 1 sec or more. The animals, with eye atropinized, were in the dark between stimuli. Reticular stimulation was applied in trains, usually 250 msec long, of 300-cy/sec pulses. Intensity, normally ranging between 50 and 150 μa, was always chosen so that it was insufficient to cause any kind of motor reaction. The position of all brain-stem electrodes was histologically verified.

One hundred units of the striate cortex were studied. It is assumed that the majority of records were extracellular and of cell-body spikes. The spontaneous rate of unit impulses varied considerably, ranging from 0 to 54 spikes per second, but most units exhibited slow (median, 1.47 spikes per second) and irregular firing. Grouped or clustered activity was seen, though it was far less common than it is in thalamic units under the same experimental conditions (*6*). According to their reactions to light, all units were classified as Jung *et al.* have done with cortical cells in the cat (*7*): 13 units showed an increment of firing rate at the onset of illumination (B-type of Jung); 14 were inhibited at the "on" of the light and showed an "off" discharge (D-type); and 21 other units reacted with increments of discharge both at "on" and "off" of the light (E-type). One-half of all units did not show any definite reactions to long dif-

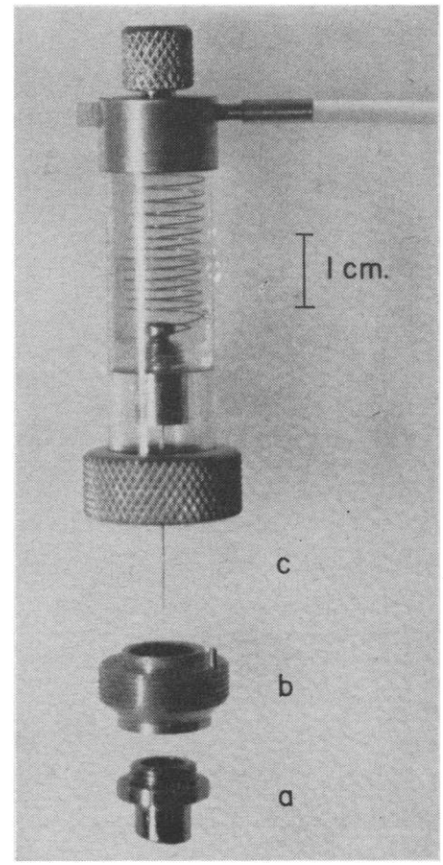

Fig. 1. Micropositioner. (*a*) Implant; (*b*) adapter; (*c*) microelectrode. The aluminum top of the cylinder is connected to the input.

fuse illumination (A-type). These units were not completely unresponsive to light, but their reactions were extremely inconstant and weak; some of them, while not responding to long light stimuli, did respond to brief flashes of higher intensity. Only two units were found to be inhibited at "on" and "off" of the light (C-type). Some units responded to moving luminous spots in the visual field, as Hubel has seen in cortical neurons of the cat (*5*), but responses of this kind were not explored systematically.

Sixty-one units were unaffected by stimulating the brain stem, but the rest showed clear frequency changes in response to this stimulus, and the effects persisted for some time after its cessation. The firing of 14 units was accelerated, while that of 25 others was slowed down by reticular stimulation alone. Although there were exceptions, it was observed that light-activated units tended to be accelerated by the reticular stimulus, whereas units showing light inhibition tended to be likewise inhibited by the reticular stimulus (Fig. 2). In many such cases light and tegmental stimulation, when applied simultaneously, interacted with each other in mutual reinforcement. The majority of those units which did not respond to light were not affected by reticular stimulation. Discharges induced by darkness, prominent in most D- and E-units at the cessation of light, were in some instances enhanced and in others inhibited by brain-stem stimulation. No correlation was found between cortical depth and types of response to either light or electrical stimulation.

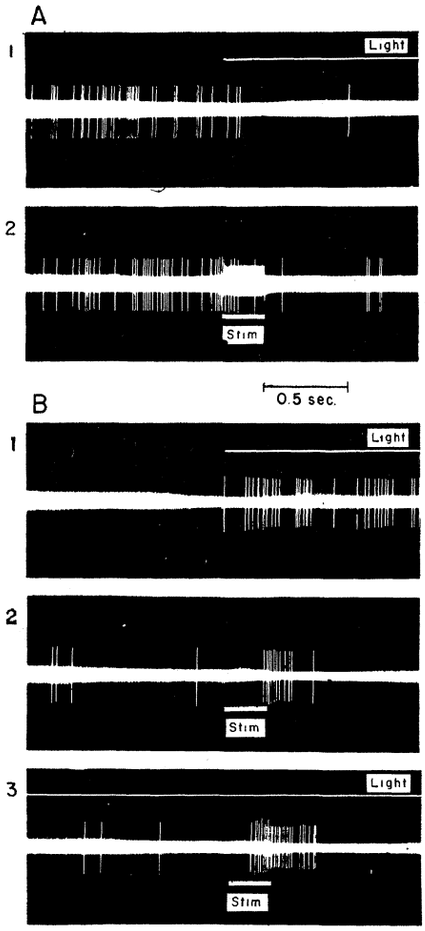

Fig. 2. Record excerpts from two single units: (*A*) *1*, light-inhibited unit; *2*, same unit in dark, inhibited by reticular stimulus. (*B*) *1*, light-activated unit; *2*, same unit activated by reticular stimulus alone; *3*, same unit, reticular stimulus during light. Records read from left to right.

This study demonstrates that reticular activation can result in excitatory or inhibitory modulation of certain neurons in the striate cortex. Furthermore, it shows that this modulation acts in many instances synergically with luminous stimuli, although more work is needed to determine how this synergism is accomplished. Since both excitatory and inhibitory synaptic effects have been demonstrated in cortical cells by stimulation of the lateral geniculate body (*8*), it is possible that the reticular influences reported here are exerted upon presynaptic neurons at the geniculate or intracortical levels.

It has been postulated (*1*) that the same basic process that secures arousal from sleep—that is, the generalized activation of the cortex by the reticular core of the brain stem—is responsible in the awake organism for the attainment and maintenance of states of high receptivity of the sensory cortex. Thus, such a mechanism might underlie a descent of sensory thresholds in behavioral alertness. Some support for this postulate is provided by the fact that reticular activation, experimentally elicited, has differential effects upon various visual cortical cells according to the characteristics of their responses to optic stimuli. It is recognized that these characteristics are determined by the nature of the receptive fields of the individual units, the spatial configuration of stimulus intensities, and other possible factors which account for the complexity of the cortical representation of visual patterns.

The probably ubiquitous character of reticular activation upon sensory areas does not preclude the existence of more specialized processes, perhaps corticothalamic, conceivably operating to channel reticular tonus, and that may be at the basis of selective focusing of attention.

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13 February 1961

Auxetic Growth in the Javanese Toad, Bufo melanostictus

Abstract. Morphologically, it has been found that erythrocyte size in the Javanese toad is greater in large than in small animals, and preliminary data indicate that the same is true of kidney, intestinal, and liver cells. Physiologically, the hemoglobin concentration, packed cell volume, specific gravity of the whole blood, and the liver glycogen concentration also increase with the size of the animals.

One of the advantages of working with tropical amphibians on Java springs from the fact that the unchanging climatic factors, especially temperature and humidity, and the unending food supply, make it possible for them to maintain constant reproductive and physiological conditions throughout the year. These conditions remain unchanged in spite of the fact that the majority of amphibians in the Indonesian Archipelago have migrated there from northern areas where they are known to undergo seasonal physiological and reproductive cycles as do other temperate-zone amphibians.

It has recently been shown by Church (*1*) and his co-workers (*2*) that in *Bufo melanostictus* and *Rana cancrivora* the reproductive patterns and underlying physiological mechanisms governing them, as indicated in the storage of liver glycogen, fat bodies, hemoglobin concentrations, and pituitary sizes and secretions, have been altered from the temperate-zone norms to favor a more