EFFECTS OF SOMBREVINE ON ORIENTATIONAL TUNING OF VISUAL CORTEX NEURONS IN THE CAT

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Changed orientational tuning (OT) in 58 visual cortex units was investigated during acute experiments on immobilized cats under light short-lasting sombrevine-induced anesthesia. A $47.6 \pm 5.6^\circ$ alteration in the preferred orientation of 60% of cells occurred following sombrevine injection but no change occurred at any stage of anesthesia in the remainder. The latter group showed a preference for horizontal and vertical orientations, less pronounced in the former category. "Stable" neurons also displayed less acute tuning and more selective detection in comparison with "unstable" units. Breadth of orientational tuning consistently changed by an average of $65.2 \pm 6.7^\circ$ in 55% of neurons, while tuning deteriorated in 31% and sharpened in 24% of cells. No regular change in tuning bandwidth occurred in the remainder. Background firing rate and evoked spike activity declined by 58% and 35%, respectively under anesthesia in 2/3 of the cells tested. Tuning bandwidth of unit firing rate had generally recovered within 20-40 min after administering the anesthetic (i.e., as the anesthesia wore off).

INTRODUCTION

A direct conflict has emerged between recent findings on the effects of anesthesia on detection in visual cortex neurons. Accordingly, certain sources maintain [12] that orientational tuning in some visual cortex units can alter drastically without any modification of preferred orientation [10-12]. Other findings would point to alteration in the bandwidth of orientational tuning (OT) under anesthesia [11]. Evidence has also been produced of changes occurring in neuronal receptive fields (RF) under anesthesia, with broadening of RF [3, 6, 7, 15] and altered location of excitatory and inhibitory zones [7, 12].
Anesthesia is known, in particular, to eliminate or attenuate activity in polysynaptic neuronal sequences [9, 18]; this, by changing the excitatory-inhibitory balance, may lead not just to rearrangement of neuronal RF in the visual cortex, but also to substantial modification of orientational detection mainly produced by such inhibition [6, 13, 16, 17, 19, 20].

This study was performed with the specific purpose of investigating feline visual cortex neurons under the effects of light, short-lasting anesthesia.

METHODS

Research was conducted during acute experiments on adult cats immobilized by d-tubocurarine, a myorelaxant. Novocaine (a long-acting local anesthetic) was filtered into the edges of surgical incisions and potentially painful sites on the soft tissue of the scalp around the head-clamped area. Stereotaxic neurosurgery following clinical practice ensured that no pain was felt by the animal during experimental procedures. Activity of single primary visual cortex (area 17) neurons was recorded by means of glass microelectrodes with a resistance of 5-20 MΩ containing 2 M NaCl. Stimulation consisting of flashing light bands of optimum size for 100-200 msec on a white screen, stimuli being individually selected for each RF and so that the center matched the discharging center of the RF. The bands were rotated around their center with a step of 5-22.5°. Stimulus intensity measured 86 cd/m² and background luminance of the screen 0.86 cd/m².

A 5% solution of sombrevine, to produce light narcosis, was injected into the femoral vein at a dosage of 3-5 mg/kg, which induces the first stage of anesthesia in animals [4]. Sombrevin is a non-barbiturate anesthetic acting mainly on the cerebral cortex and reticular formation [4] for a 5-10 min period.

Testing of OT took place prior to and several times after sombrevine administration. The second measurement was begun 1-2 min after injection and repeated after 15 and 35 min as the anesthesia wore off. Orientational function was thus measured not less than 3-4 times in each neuron. Between 8 and 10 min were required for each complete measurement of OT; the entire trial for a single unit lasting over 1 h. Changeability of OT pattern with no anesthesia was measured in control experiments.

Neuronal response was assessed from peristimulus histograms (PSH) produced by computer for each of 8-10 stimulus orientations over 20 events with a bin width of 10 msec and an epoch of analysis of 1,280 msec. The computer separated response differing consistently from background activity in PSH and produced graphs plotting parameters of response against stimulus orientation [5, 6]. Preferred stimulus orientation (F₀) at which peak response occurred was determined from these plots; breadth of OT (F₁, angular deg) was found from the level of 0.66 from the difference between peak response level and mean background level, averaged parameter of this width (F₁/180, where 180 is the entire extent of the orientation range, deg), selectivity of tuning (R), calculated as the ratio of peak to minimum response level, and generalized quality of orientational detection, in direct proportion to selectivity and inverse proportion to relative width (F = 180 × R/F₁).

RESULTS

Change of OT under the effects of sombrevine was investigated in 58 primary visual cortex neurons. Sombrevin was found to induce consistent changes in some or other aspects of orientational detection in the majority of these units (45 cells or 78%) although changes differed in level and even in sign according to the cell.

Preferred orientation is a considerable proportion of test cells (23 out of 58, or 40%) did not change regularly, remaining stable after sombrevine administration. It will be seen from Fig. 1a that the control orientation (of 112°) remained optimum for one such unit at different stages of sombrevine action. Conversely, preferred orientation shifted by an angle of between 22 and 157° after injecting sombrevine (average: 47.6 ± 5.6°). In control experiments entailing measurement of OT several times in the same unit without treatment with sombrevine, this shift averaged only 10 ± 3.0°. Mean experimentally obtained and control measurements of shift in F₀ differed significantly (P < 0.01). The greatest shifts in preferred orientation occurred far more commonly during the first minutes after sombrevine application, but took place at the 10th or even the 30th minute of action in certain neurons.

Figure 1b shows an extreme example of tuning during anesthesia in the form of complete disappearance of unit response to stimulus presentation angled at the previous preferred