

HABITUATION OF UNITARY RESPONSES IN THE SUPERIOR COLLICULUS OF THE CAT

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The effects of repetitive visual stimulation on unitary responses in superior colliculus have not been systematically investigated. The habituation of these responses was, however, observed by some authors (Bell et al. 1964, Horn and Hill 1966, McIlwain and Buser 1968, Sprague et al. 1968). In our recent investigations (Harutiunian-Kozak et al. 1970ab) we have also observed that in the tecto-pretectal region of the cat the responses of the majority of neurons easily habituate with repetition of a visual stimulus. In this communication some further observations on the diminution of responses of single units in superior colliculus to moving visual stimuli are presented.

Fifty visual neurons were investigated in 14 cats. The animals were unanesthetized cats with a pretrigeminal section. After the operation Flaxedil (20 mg/kg) was given as a myorelaxant, and pupils were dilated by 0.1% atropin sulfate. The body temperature was maintained at 37–38°C by a heating pad with an autothermocorelator device. Recordings were made extracellularly by means of tungsten microelectrodes, covered with vinyl varnish, with a tip diameter 2–5 μ . A Grass P-6 amplifier was used for the amplification of cell spikes. Amplified impulses were fed into a Tectronix 502 CRO, from which they were photographed by a Grass camera. The stimulus was a 5° light spot moving in front of the eyes (70 cm distance) on a perimeter screen in the vertical or horizontal directions. The intensity of light spot was 4.5 cd/m².

Habituation was observed in about 60% of collicular units, and there

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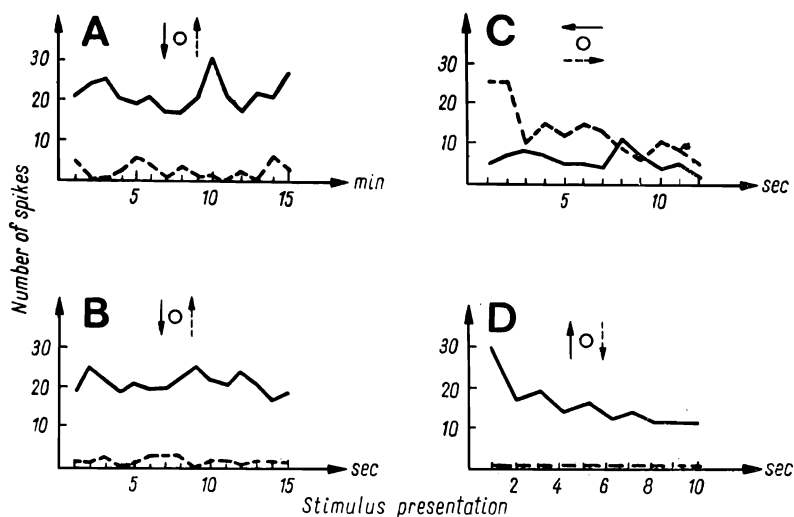


Fig. 1. Responses of direction-sensitive neurons to a repetitive presentation of the moving 5° light spot. The spot moved with a speed of $60^\circ/\text{sec}$. During 500 msec it moved in one direction and during the following 500 msec in the opposite direction. In A the intertrial intervals were 1 min, in C, B and D the spot was moving continuously. In C and D the neurons show habituation but not in A and B.

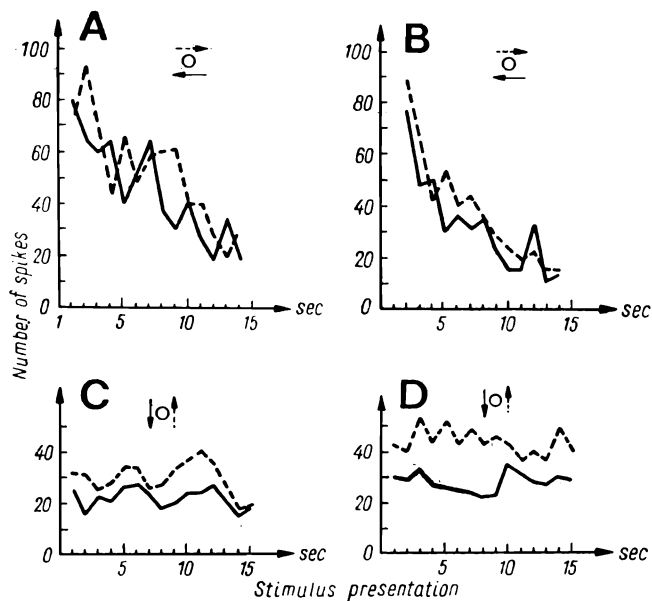


Fig. 2. Responses of directionally non-sensitive neurons to repetitive presentation of a moving stimulus. In A and B two sessions of a habituating neuron are shown, and in C and D with the non-habituating one. The intersessional intervals were 3 min. Other denotations as in Fig. 1.

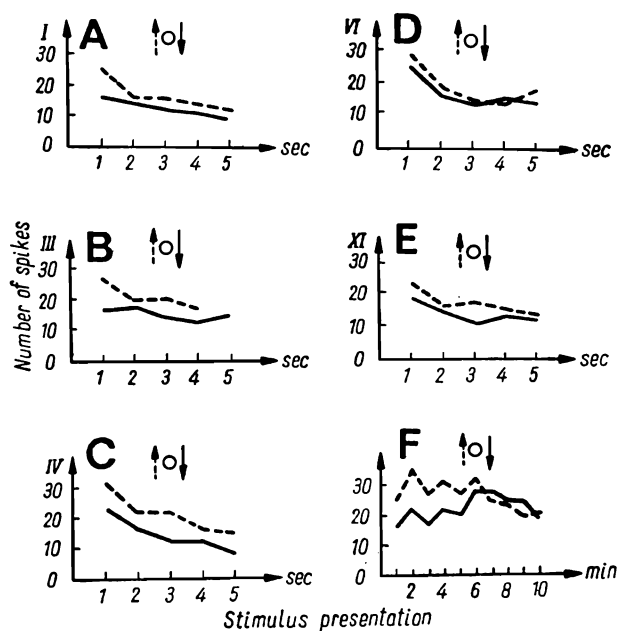


Fig. 3. Lack of potentiation of habituation. Eleven sessions were done, each session composed of five stimuli. The intersessional intervals were 1 min. In F the session with the same neuron with longer interstimuli intervals is presented. Other denotation as in Fig. 1.

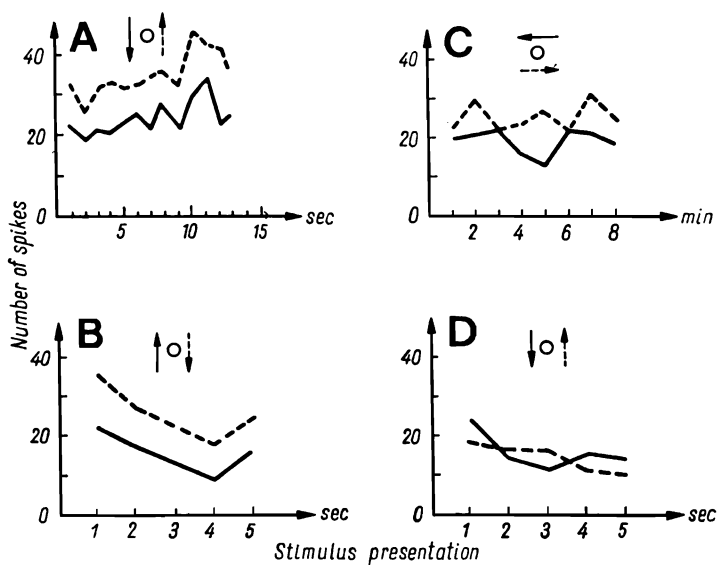


Fig. 4. Explanations in text.

were strong individual differences in the rate of habituation. The responses of the majority of direction-sensitive neurons were easily habituated (Fig. 1CD). There were different rates of habituation for opposite directions of spot movement. The responses to the preferred direction seemed to habituate more rapidly than those to the null direction. In fact, the responses to the preferred direction declined abruptly on the second or third trial and never reached its previous level. The habituation could be also observed in some directionally non-sensitive neurons (Fig. 2). The full recovery was already present after 1 min, and we never observed potentiation of habituation (Fig. 3).

In the majority of neurons there were some oscillations of responses to the movements in two opposite directions, but without any regularity. However, in some cells the changes in the number of spikes in response to stimulus moving in the different directions showed some correlation. Figure 4 represents some of our observations concerning the above mentioned characteristics. Figure 4AB represents examples (two different cells) when the responses to two different directions changed almost identically. Figure 4DC shows opposite cases. When the response in one direction increased, the response in the opposite direction showed a diminution in the number of spikes. Thus during the investigation of such neurons with a single stimulus presentation, one may have troubles with correct identification of the preferred and null directions.

The problem arises whether the diminution of responses was connected with some inhibitory process, or it was just the cell fatigue. Single unit investigations show that the process of recovery of neurones in the central nervous system has a variable time course. Generally it is presumed that it lies in the range of 10–30 msec (Curtis and Eccles 1960). According to recent results of Sefton (1969), who measured the recovery processes of single cells in rat superior colliculus, it is 10–25 msec. It seems probable that there are no great differences in the standards of this kind. In our experiments the maximal frequency of the moving stimulus was 1/sec, i.e. the time of the sweep of the light spot in one direction was 500 msec and in the opposite direction again 500 msec. These measurements in relation with the receptive field size and the time which is needed to reach the field show an about 300 msec interval between each receptive field stimulation. It is clear that during this time the cell is quite capable to recover after its membrane changes. Thus we can conclude that there is some inhibitory process which keeps the neuron in depression during the next repetition of a stimulus.

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