THE RESPONSE PATTERNS OF COLLICULAR NEURONS TO MOVING STIMULI IN CATS AFTER LESION OF THE VISUAL CORTEX

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Abstract. The speed and direction selectivity of responses of collicular neurons in pretrigeminal cats following lesions of the visual cortex were examined using moving light spots. Following cortical lesions the number of cells showing direction selectivity was reduced, but the number of cells showing speed selectivity was increased. It is suggested that some of the characteristics of collicular neurons are dependent on initial organization of the intracollicular synaptic connections rather than the corticocollicular ones.

We showed previously (4) that the direction selectivity displayed by collicular neurons of the cat in response to moving visual stimuli has a dynamic character. The magnitude of the response and direction selectivity of a given neuron are related to the speed at which stimuli are moved across the screen, as well as to the intensity of background illumination of the screen against which visual stimuli are presented.

We know (7, 11) that the afferent inputs from the retina and the visual cortex converge upon the same neurons located in the upper layers of the superior colliculus. It is also generally agreed that these two projections contribute to the properties of the collicular neurons (1, 6, 8, 10, 12, 13). In the present study we have investigated the response patterns of collicular neurons to moving stimuli, after the influence from visual cortex is removed.

Experiments were performed on cats with pretrigeminal brainstem
transection (14). Animals were paralyzed and artificially resired. The CO$_2$ level and the temperature of the animals were monitored during experiments. One percent atropine and 10% neosynephrine were topic-

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Fig. 1. Medial and dorsal aspects of the lesions. A: Extensive removal of the visual cortex; B: Lesion of visual areas 17 + 18.
ally applied to dilate the pupil and retract the nictitating membranes. A contact lens of zero-power was applied on the eye to protect the corneal surface. The eye ipsilateral to the recording site was occluded. Light flash and moving spots of different sizes (1 to 8°) and velocities (8, 16, 40, 80 and 160°/s) projected against a screen located 70 cm from cat’s eye were used for stimulation. The background illumination of the screen was 0.8 cd/m². The activity of single neurons was recorded with metal microelectrodes. Neural discharges were transformed into standard pulses to produce poststimulus time histograms from which response patterns of isolated neurons were analyzed (5).

Fifteen cats with ablated unilaterally visual cortex were used. In ten cats visual cortex was removed five hours prior to acute experiments: seven animals from this group were subjected to extensive lesion of the visual cortex (Fig. 1A), whereas in three animals the lesions were limited to areas 17 and 18 (Fig. 1B). In another five cats large lesions were made in aseptic conditions under pentobarbital anesthesia 4 days prior to acute experiments. Lesions were reconstructed from 40 μm sections stained with cresyl violet.

The results are presented in Table I and Fig. 2. It is seen that the number of neurons of each population possessing the same functional characteristics are comparable for each experimental group, except that the number of cells sensitive to diffuse-flash is almost twice as great as in animals with lesions limited to area 17 – 18.

**Table I**

<table>
<thead>
<tr>
<th>Group</th>
<th>Tested systematically</th>
<th>Direction selective</th>
<th>Speed selective</th>
<th>Preferring low-speed</th>
<th>Preferring high-speed</th>
<th>Respon- sive to diffuse flash</th>
</tr>
</thead>
<tbody>
<tr>
<td>Large acute lesion of the visual cortex (7 cats)</td>
<td>34</td>
<td>9</td>
<td>17</td>
<td>15</td>
<td>2</td>
<td>26</td>
</tr>
<tr>
<td>Large chronic lesion of visual cortex (5 cats)</td>
<td>23</td>
<td>5</td>
<td>9</td>
<td>8</td>
<td>1</td>
<td>17</td>
</tr>
<tr>
<td>Small acute lesion: (areas 17+18) (3 cats)</td>
<td>24</td>
<td>9</td>
<td>18</td>
<td>11</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>All groups</td>
<td>81</td>
<td>23</td>
<td>54</td>
<td>34</td>
<td>10</td>
<td>53</td>
</tr>
</tbody>
</table>

Our present results were compared with previous data (3) performed on pretrigeminal cats with intact visual cortex. In non-lesioned cats about 66% of neurons displayed direction selective responses, while in
present data only 30\% of neurons were direction selective. Further analysis of results also reveals that in ablated animals an increased number of neurons sensitive to low speed of spot movement. Only 25\% of neurons recorded in unlesioned animals were sensitive to a speed of 8°/s while in ablated animals the number of cells sensitive to slow movement increased to 40\%.

![Fig. 2. Poststimulus time histograms of three different cells recorded in a cat with a large chronic lesion of the visual cortex. A: Neuron displaying patterns of firing independent of the direction of stimulus movement. B: Example of direction selective neuron. C: Neuron displaying decreased firing rate in response to a spot of light moving through its receptive field. In A and B velocity of stimulus movement was 80°/s, bin width 3.2 ms and in C the velocity was 40°/s, bin width 6.4 ms. N, number of repetitions. Arrows indicate direction of stimulus movement.](image)

From our results it is also clear that collicular neurons devoid of influence from visual cortex are capable of generating patterns of responses to moving stimuli similar to those recorded from collicular cells in animals with intact visual cortex (2,9). The proportion of cells belonging to particular groups is shifted in the same direction as in experiments performed on preparations in which superior colliculus was isolated by sectioning rostral and caudal to it (3). The results obtained on cats deprived of visual cortex showed that collicular neurons still possess all of the characteristic features in response to moving visual stimuli as in intact animals. This suggests that specific responses of collicular neurons could result from the structural organization of the superior colliculus itself.

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2. Dec, K. and Tarnecki, R. 1975. The responses of neurones of cat's superior colliculus to visual stimuli after acute removal of the visual cortex (in


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