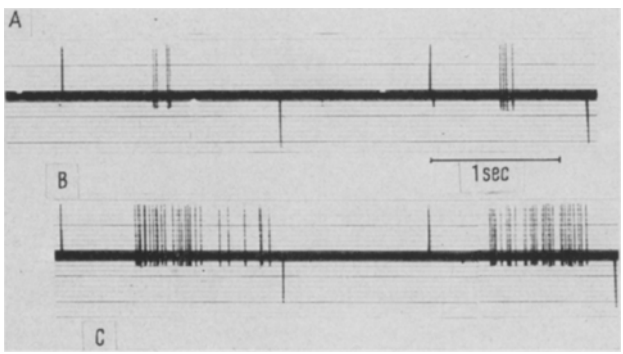
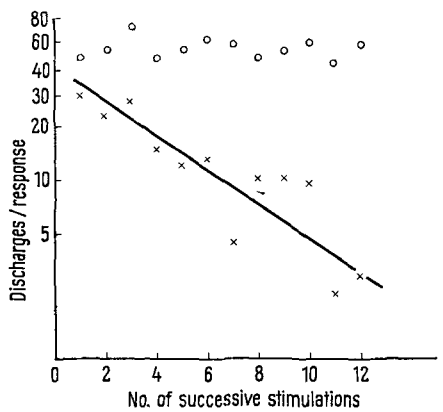
Effect of D-Amphetamine on the Activity of Single Neurons of the Cat's Tectum opticum

The neurons of the cat's tectum opticum respond optimally to moving visual stimuli[1,2]. Most of them are directionally selective, i.e. strength of response depends on the direction of movement[1,2]. With repetitive stimulation the response usually decreases (adaptation, habituation; [2]). This attenuation of response is especially marked in the so-called novelty-detecting neurons of the deeper layers[3] of the tectum opticum (str. intermedial, str. prof.). The results of destructions of the tectum opticum suggest the existence of tectal neural mechanisms which underlie some motor correlates of visual attention and visually elicited orienting responses[4]. Adaptation of tectal neurons to repeated stimuli may thus be related to decrease of visual attention during repetitive stimulation (habituation). D-Amphetamine, which enhances visual attention in connection with an increase of general vigilance, should therefore influence the activity of some tectal neurons.

Methods. In order to test this hypothesis, we recorded with steel-microelectrodes from single tectal neurons before and after i.v. injection of D-amphetamine (2–4 mg/kg). Cats were immobilized by flaxedil and given artificial respiration. Expiratory CO_2 and body temperature were monitored. As stimuli served moving projections of luminous discs or black targets, which were moved by hand in front of a screen. Receptive fields and preferred direction of movements were determined for each neuron tested. Activity was recorded on film. Total number of discharges and discharge-rate during traversion of the receptive field were determined. The position of the electrode-tip was marked by perfusing the animal with a solution containing potassium ferrocyanide. All 10 neurons tested were recorded in layers below the str. opticum and were characterized by absent or low spontanous activity, large receptive fields and marked adaptation.





A and B, reactions of a directionally selective neuron to vertical movements of a bright disc before (A) and after i.v. injection of 3 mg/kg D-amphetamine (B). Upward (downward) directed artefact indicates inition of upward (downward) directed movement. C, graphical representation of neuronal responses to successive movements of a bright disc before (× × ×) and after 3 mg/kg D-amphetamine (○○○). Abscissa first, second, third to *n*th successive movement. Ordinate: number of impulses/movement. Stimulation-rate: 0.2/sec. Cat; tectum opticum; flaxedil.

Results. In all neurons tested amphetamine increased the total number of discharges of the first unadapted response of a stimulation-series by a factor ranging from 1.5–6.6 (Figure). The increased total number of impulses was a consequence of increased rate and/or duration of response-discharge. Rate of the first unadapted response increased by a factor ranging from 1.2–2.3, duration by a factor ranging 1.1–4.8. The difference between number of impulses before and after amphetamine was highly significant (*t*-test, $p < 0.005$; sign-test, $p < 0.001$). In a few cases receptive field diameters were determined before and after amphetamine and were found increased in the latter case. In all neurons tested, amphetamine prevented or diminished neuronal adaptation to repeated stimulation (Figure c).

Directional selectivity and orientation of preferred directions were not influenced by amphetamine. Spontanoeusly inactive neurons remained so after amphetamine, although spontaneous activity, if present, used to increase after injection. The effects of D-amphetamine could be reversed by i.v. injection of pentobarbital (2–5 mg/kg).

Our results indicate that D-amphetamine increases the excitability of tectal neurons but they do not reveal the primary site or the mechanism of drug action. Results of other experiments[5,6] suggest that the effects of D-amphetamine on EEG and behaviour are primarily mediated by rostral mesencephalic structures related to or possibly identical with the mesencephalic reticular formation. The tectal effects of amphetamine may be explained as mediated by a reticulo-tectal input, but a direct drug action on tectal neurons cannot be excluded. Furthermore, the possibility of changes in the cortico-tectal afference must be considered in view of the well-known effects of D-amphetamine on neurons of the visual cortex[7]. As to the mechanism of action, excitation or release from inhibition (disinhibition) are equally possible alternatives.

Zusammenfassung. D-Amphetamin (2–4 mg i.v.) verstärkt bei Neuronen des Tectum opticum der Katze die Reizantwort auf optische Bewegungsreize und vermindert oder beseitigt die während einer Reizfolge auftretende neuronale Adaptation.

M. STRASCHILL and K. P. HOFFMANN

Max-Planck-Institut für Psychiatrie, 8 München 23 (Germany), 28 November 1968.

[1] J. MCILWAIN and P. BUSER, Expl Brain Res. *5*, 314 (1968).
[2] M. STRASCHILL and A. THAGHAVI, Expl Brain Res. *3*, 353 (1967).
[3] M. STRASCHILL and K. HOFFMANN, Brain Res. *8*, 382 (1968).
[4] J. M. SPRAGUE and T. MEIKLE, Expl Neurol. *11*, 115 (1965).
[5] P. BRADLEY and I. ELKES, Brain *80*, 71 (1957).
[6] G. METER and G. AYALA, Electroenceph. clin. Neurophysiol. *13*, 382 (1961).
[7] A. HERZ and J. FUSTER, Arch. exp. Path. Pharmak. *249*, 146 (1964).