Octopamine responses of neurones in the rat thalamus

W.P.C. DAO & R.J. WALKER

School of Biochemical & Physiological Sciences, University of Southampton, Southampton SO9 3TU

There is considerable pharmacological and electrophysiological evidence to suggest that octopamine is a transmitter or modulator in the invertebrates (Robertson & Juorio, 1976; Walker & Kerkut, 1978). Although small amounts of octopamine have been found in specific regions of the mammalian brain, the precise role of octopamine in these areas is unknown (Braudau & Axelrod, 1972; Buck, Murphy & Molinoff, 1977). There is indirect evidence to suggest that octopaminergic neurones and specific receptors for octopamine are present in the mammalian central nervous system (Hicks & McLennan, 1978; Henwood, Boulton & Phillis, 1979). The present report presents evidence in support of the presence of specific octopamine receptors in the rat thalamus.

Male and female Wistar rats (150–200 g) were anaesthetized with urethane (1.5 g/kg, i.p.). Potentials were recorded extracellularly and drugs applied iontophoretically using either 6 or 8 barrel microelectrodes as previously described (Crossman, Walker & Woodruff, 1974; Wang & Aghajanian, 1977). The protruding recording barrel and the indifferent barrel contained pontamine sky blue 2% in 0.2 M NaCl. The drug barrels contained one of the following: L-glutamate, DL-homocysteic acid (both pH 9.0, 0.5 M), acetylcholine, γ-aminobutyric acid, dopamine, (−)-α-methyloctopamine, (±)-N-methyloctopamine, (−)-noradrenaline, (±)-octopamine, (+)-octopamine, (−)-octopamine, (±)-meta-octopamine (all pH 4.0, 0.5 M), and the antagonists cis-flupenthixol, fluphenazine, metoclopramide, propranolol (all pH 4.0, 0.2 M). All compounds were ejected as cations except glutamate and homocysteic acid which were ejected as anions. Each drug was tested on at least 20 cells and cells identified by stimulating either the frontal cortex, contralateral peroneal or sciatic nerve or the locus coeruleus. Cells were subsequently located histologically.

(−)-Noradrenaline and (±)-octopamine applied at currents of up to 90 nA increased the firing rate of 13/85 and 10/85 cells respectively and decreased the firing rate of 41/85 and 46/85 cells respectively. Dopamine (up to 90 nA) inhibited 38/65 and excited 5/65 cells. These cells were located in the thalamus, mainly in the ventral basal complex. There was no consistent correlation between the actions of the three amines, ie, while noradrenaline might excite a neurone, octopamine might excite, inhibit or be inactive on the same cell. Fluphenazine, *cis*-flupenthixol, metoclopramide and propranolol were examined as antagonists of the three amines. However none of these antagonists showed a clear and consistent specificity for any of the amines. Although fluphenazine partially blocked dopamine responses but not octopamine when applied at low currents (up to 30 nA). (±)-Meta-octopamine and (−)-α-methyloctopamine were less potent than (±)-octopamine on thalamic neurones indicating some structural specificity for the receptors. The stereo-selective (−) isomer of octopamine was 2–4 times more potent than the (+) isomer showing a stereo-specificity of the receptors. These results show that octopamine is active on thalamic neurones and present some evidence for specific octopamine receptors in this region.

We are grateful to Hoffmann-La Roche for (+)- and (−)-octopamine.

References

BRAUDAU, K. & AXELROD, J. (1972). The biosynthesis of octopamine. *Naunyn-Schmiedebergs Arch. Pharmac.*, **273**, 123–133.

BUCK, S.H., MURPHY, R.C. & MOLINOFF, P.B. (1977). The normal occurrence of octopamine in the central nervous system of the rat. *Brain Res.*, **122**, 281–297.

CROSSMAN, A.R., WALKER, R.J. & WOODRUFF, G.N. (1974). Problems associated with iontophoretic studies in the caudate nucleus and substantia nigra. *Neuropharmac.*, **13**, 547–552.

HENWOOD, R.W., BOULTON, A.A. & PHILLIS, J.W. (1979). Iontophoretic studies of some trace amines in the mammalian central nervous system. *Brain Res.*, **164**, 347–351.

HICKS, T.P. & MCLENNAN, H. (1978). Comparison of actions of octopamine and catecholamines on single neurones of the rat cerebral cortex. *Br. J. Pharmac.*, **64**, 485–491.

ROBERTSON, H.A. & JUORIO, A.V. (1976). Octopamine and some related noncatecholic amines in invertebrate nervous systems. *Int. Rev. Neurobiol.*, **19**, 173–224.

WALKER, R.J. & KERKUT, G.A. (1978). The first family (adrenaline, noradrenaline, dopamine, octopamine, tyramine, phenylethanolamine and phenylethylamine). *Comp. Biochem. Physiol.*, **61C**, 261–266.

WANG, R.Y. & AGHAJANIAN, G.K. (1977). Recording of single unit activity during electrical stimulation and microiontophoresis: A method of minimizing stimulus artifacts. *Electroenceph. Clin. Neurophysiol.*, **43**, 434–437.