depressed most of the cells tested. The ejection of aminophylline produced a rapid and reversible reduction of responses to both adenosine and morphine on all 15 neurones tested. Nine of these cells showed an increase in firing rate during the application of aminophylline, the doses of which ranged from 14 to 90 nA. Responses to GABA were never affected by aminophylline.

Naloxone proved able to reduce the depressant effects of morphine but not adenosine, when applied with low currents of 10–25 nA to reduce direct depression by naloxone. The morphine depressions thus appear to be a specific effect.

These results support the idea that the first consequence of the interaction of morphine with its receptor is the local release of adenosine.

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Reference

JHAMANDAS, K., SAWYNOK, J. & SUTAK, M. (1978). Antagonism of morphine action of brain acetylcholine release by methylxanthines and calcium. *Eur. J. Pharmac.*, **49**, 309–312.

Behavioural scoring—how good is the agreement between scorers?

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Behavioural models are used increasingly to determine neurotransmitter receptor sensitivity. However, there are problems in quantifying such models as characteristics can only be assessed subjectively. Examples of such models are the behavioural syndromes seen in rats after administration of either p-chloroamphetamine (PCA) (Trulson & Jacobs, 1976) which releases brain 5-HT (Conti, Strope, Adams & Marsden, 1978), or tryptamine plus a monoamine oxidase inhibitor (Marsden & Curzon, 1978). Both syndromes are characterised by lateral head weaving, forepaw treading, hind limb abduction and straub tail. One method of assessment is to score the presence of each behavioural component on an integral 0–3 scale (0 = absent, 1 = occassional, 2 = frequent, 3 = continual) during 1 min observation periods (Marsden & Curzon, 1978). This report outlines a study to determine the scoring agreement between 5 trained observers rating such behaviour and the use of the method to compare the effects of (±)-propranolol on the behavioural syndromes produced by PCA and by tranylcypromine (TCP) + tryptamine.

Unlabelled video cassette films made of the behaviour of 18 male Wistar rats for 60 min after treatment with either PCA (7.5 mg/kg) or tryptamine (5 mg/kg) 30 min after TCP (10 mg/kg) were viewed in random order by five trained observers who simultaneously and independently rated the filmed behaviour. Using the non-parametric Friedman test (Marascuilo & McSweeney, 1977), casting the results matrix with the scores for each film forming the 18 rows, each syndrome characteristic and the totals were analysed, demonstrating that the observers did not differ significantly from each other in their scoring technique.

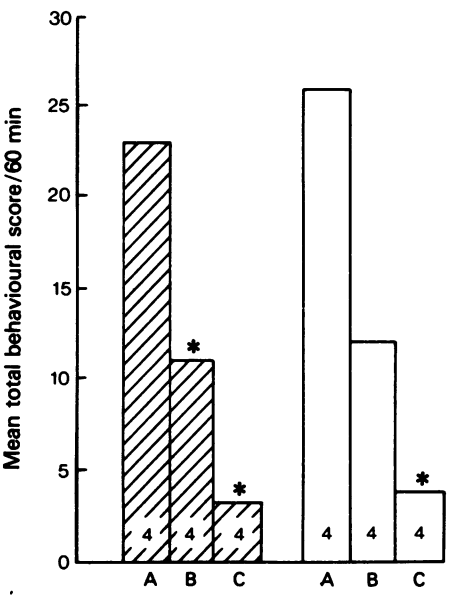

Figure 1. Effect of (±)-propranolol (20 and 40 mg/kg) on the behavioral score induced by either tranylcypromine (10 mg/kg) plus tryptamine (5 mg/kg) 30 mins later (□) or *p*-chloroamphetamine (7.5 mg/kg ■). (±)-Propranolol was given 30 min before either tranylcypromine or *p*-chloroamphetamine. A = saline, B = (±)-propranolol 20 mg/kg, C = (±)-propranolol, 40 mg/kg. *Significant decrease from saline pretreated group ($P < 0.05$—Mann Whitney U test).

Observer agreement was determined using Kendell's Concordance (Marascuilo & McSweeney, 1977) with corrections for tied values. Acceptable agreement between the 5 observers' scores was demonstrated: concordance = 0.73 ($P < 0.005$). No obvious differences were detected between the behavioural syndromes induced by either PCA or tryptamine.

(±)-Propranolol (40 and 20 mg/kg) given 30 min before either PCA (7.5 mg/kg) or TCP (10 mg/kg) plus tryptamine (10 mg/kg) significantly reduced the behavioural scores in both situations. Behaviour was again scored using unmarked video cassette recordings.

The results demonstrate the inter-scorer reliability of the scoring technique subject to suitable observer training. The similarity of the PCA and tryptamine behavioural syndromes and the confirmation of their common blockade by propranolol (Deakin & Green, 1978) is further evidence that they both induce the syndrome via a common receptor.

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References

CONTI, J.C., STROPE, E., ADAMS, R.N. & MARSDEN, C.A. (1978). Voltammetry in brain tissue: chronic recording of stimulated dopamine and 5-hydroxytryptamine release. *Life Sci.*, **23**, 2705–2716.

DEAKIN, J.F.W. & GREEN, A.R. (1978). The effects of putative 5-hydroxytryptamine antagonists on the behaviour produced by administration of tranylcypromine and L-tryptophan on tranylcypromine and L-DOPA to rats. *Br. J. Pharmac.*, **64**, 201–209.

MARASCUILO, L.A. & MCSWEENEY, M. (1977). *Non-parametric and distribution free methods for the social sciences.* Brooks/Cole, Monterey, U.S.A.

MARSDEN, C.A. & CURZON, G. (1978). The contribution of tryptamine to the behavioural effects of L-tryptophan in tranylcypromine-treated rats. *Psychopharmac.*, **57**, 71–76.

TRULSON, M.E. & JACOBS, B.L. (1976). Behavioural evidence for the rapid release of CNS serotinin by PCA and fenfluramine. *Eur. J. Pharmac.*, **36**, 149–154.

The relative contribution of iontophoresis and electro-osmosis to the electrophoretic release of noradrenaline from multibarrelled micropipettes

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The electrophoretic release of drugs from micropipettes involves two processes: (i) ejection of ionised drug molecules by iontophoresis, and (ii) ejection of small volumes of the drug solution by electro-osmosis. Of the two, iontophoresis is generally believed to make the greater contribution towards total release, at least in the case of well ionised drugs (Curtis, 1964).

We have attempted to assess the contribution of electro-osmosis to the total release of noradrenaline from multibarrelled micropipettes by measuring the rate at which a practically unionised molecule, glucose, is released concomitantly with noradrenaline during the passage of electrophoretic currents. Ten six-barrelled micropipettes were used; three barrels (nos. 1–3) of each micropipette were filled with a mixture of [^{14}C]-noradrenaline bitartrate (0.05 M; S.A.: 1 mCi/mmol) and glucose (0.0167 M), and the remaining three (nos. 4–6) with a mixture of noradrenaline bitartrate (0.05 M) and [^{14}C]-glucose (0.0167 M; S.A.: 1 mCi/mmol). In each micropipette the rate of efflux of radioactive material was measured during a series of 10 min periods. In calculating the rate of electrophoretic release of [^{14}C]-glucose or [^{14}C]-noradrenaline, the mean rate of spontaneous efflux of radioactive material was subtracted from the toal rate of release of radioactive material. (This spontaneously released radioactive material presumably consisted of both [^{14}C]-glucose and [^{14}C]-noradrenaline.) The rate of release of [^{14}C]-noradrenaline was measured during the passage of currents of +25, +50, +75 and +100 nA through barrels 1–3 (four samples at each current value), and the rate of release of [^{14}C]-glucose was measured during the passage of identical currents through barrels 4–6. The latter measurements were used to calculate the rate of ejection of the solution from the micropipette, which in turn was used to calculate the rate of release of noradrenaline by electro-osmosis. By subtracting the calculated rate of electro-osmotic release of noradrenaline from the total rate of electrophoretic release of noradrenaline, the rate of iontophoretic release of noradrenaline was estimated. 'Apparent' and 'real' transport numbers for noradrenaline were calculated from the measured rates of total electrophoretic release and the estimated rates of ionotophoretic release respectively.

The mean 'apparent' transport number for noradrenaline (±s.e.m.) was 0.286 (±0.022). Electro-osmo-