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Trace amines recruit motor activity in the isolated neonatal rat spinal cord

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The trace amines (TAs) are present in the mammalian CNS in low concentrations with uncertain physiological actions. Borowsky et al (2001) identified a large family of metabotropic TA receptors supporting a role for the TAs as modulatory transmitters in the CNS. Previously, we demonstrated that the TAs, tyramine, tryptamine, and β-phenylethylamine (PEA) are capable of producing locomotor-like activity (LLA) in the isolated neonatal rat spinal cord (Gieseker et al SfN 2004). Here, we further characterize these actions including assessment of the TA, octopamine.

Bath application of all TAs was able to increase spontaneous motor activity. For tyramine, we observed a concentration dependent increase starting at a dose of 1 μM. For tyramine and tryptamine, the increased excitability persisted in a nominally Ca^{2+}-free artificial CSF demonstrating a contribution from direct excitatory actions on motoneurons. Pre-application of monoamine oxidase inhibitors did not increase TA-evoked motor activity, suggesting that TA actions were unaffected by endogenous monoamine oxidases. Slow LLA could be produced by application of tyramine or tryptamine alone. Co-application of the TAs with NMDA produced LLA whose frequency, amplitude, and phase relations were generally comparable to 5-HT/NMDA. However, more complex LLA patterns could be seen with tyramine and PEA. Methysergide is both an antagonist to 5-HT receptors and to a tryptamine binding site. At 1 μM, methysergide blocked all tryptamine-induced LLA (6/6) and most LLA induced by 5-HT (7/10). In contrast, methysergide was less effective for tyramine (2/7) suggesting that tyramine acts on a different receptor.

Immunostaining for tyramine, tryptamine, and octopamine identified somatic labeling in many neurons including motoneurons. Differential labeling patterns were seen among the TAs with predominant ventral horn labeling, particularly for tyramine. Octopamine had the most widespread labeling, including the dorsal horn. Overall, the existence of TAs in neurons concentrated in spinal motor regions, their recruitment of motor activity at low doses, and their ability to activate LLA, support the notion that TAs are endogenous neuromodulatory transmitters in the mammalian spinal cord.

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