Monoamine Oxidase Activity in Various Parts of the Rat Brain during the Estrous Cycle

Abstract. *The activity of monoamine oxidase was estimated in the hypothalamus, amygdala, and frontal cortex of adult female rats during the estrous cycle. Enzymatic activity in all three areas of brain was at its lowest during the diestrus phase of the estrous cycle and progressively increased to its highest during estrus. Throughout the estrous cycle the greatest activity of monoamine oxidase was found in the hypothalamus, as compared with the other brain areas. The significance of the activity is discussed.*

Since the discovery of monoamines —5-hydroxytryptamine (5-HT), norepinephrine (NE), and epinephrine—in the brain of mammals some 10 years ago (*1*), several theories have been advanced to clarify their functional role in the physiology of the brain. Most information concerning the functions of monoamines was obtained from experiments with the administration of various drugs that increase the intracellular free pool of monoamines either by blockage of their degradation (monoamine oxidase inhibitors) or by blockage of repeated cellular uptake of the monoamines (imipramine-like drugs) or that decrease the intracellular free pool of monoamines with reserpine-like drugs. The effects of the above-mentioned drugs on behavior have been reviewed (*2*).

It is the consensus of investigators working in this area that the intracellular free pool of monoamines represents the active physiological fraction (*2*). Evidence exists that 5-HT and NE function as neurotransmitters at the synapse of adrenergic neurons, with their greatest distribution in the brain occurring primarily in the cellular regions of the telencephalon and diencephalon (*2*).

Since hyperactivity is associated with the estrus stage of the estrous cycle (*3*) and hyperactivity has been associated with high concentrations of monoamines, we decided to find out whether monoamine concentrations in various brain parts (hypothalamus, amygdala, and frontal cortex) can be correlated with the estrous cycle. The amygdala was chosen because of its role in the regulation of gonadotropin secretion and its role in the regulation of many behavioral phenomena, including mating (*4*).

Instead of estimating the monoamines directly, monoamine oxidase (MAO) was estimated since this enzyme is responsible for the eventual oxidative deamination of monoamines. In addition, MAO deaminates only the physiologically important intracellular free monoamines.

Groups of ten female rats each were killed by decapitation during diestrus, proestrus, and estrus. The brains were exposed and the frontal cortex, hypothalamus, and amygdaloid regions were dissected out, weighed, and quickly frozen over dry ice for later analysis. Monoamine oxidase activity was estimated on these brain areas within 1 week after collection, according to the method of McCaman *et al.* (*5*).

A trend of increasing MAO activity occurred in all areas of the brain investigated (Table 1). The mean MAO activity in the amygdala increased approximately 250 percent from the diestrus value to the proestrus value, where it remained essentially unchanged into estrus ($P < .01$). The mean MAO activity in the frontal cortex and hypothalamus followed the same general trend as in the amygdala, increasing by 210 and 220 percent, respectively ($P < .01$).

The greatest amount of MAO activity was found in the hypothalamus, with the least occurring in the frontal cortex. These distributions agree well with MAO distributions reported by Weiner for dog, cow, and human brain (*6*).

Since this is the first attempt at correlating MAO activity in the brain with the estrous cycle, any attempt to explain the significance of this cyclic activity would be mere conjecture. O'Steen reported that 5-hydroxytryptamine (5-HT) inhibits ovulation in the rat, implying that the inhibition is a result of depressed luteinizing hormone (LH) secretion (*7*). Since the last link in the train of neurophysiological events responsible for secretion of the LH-releasing factor occurs in the hypothalamus, it should not seem unreasonable that titers of MAO would be highest in this structure in order to override the inhibiting effect of 5-HT at the proestrus and estrus stages of the estrous cycle. Because the amygdala also regulates gonadotropin secretion, its distribution of MAO should parallel the MAO distribution in the hypothalamus. This was found to be the case. However, it should not be implied that the amygdala regulates the secretion of LH-releasing factor, but that it may play a role in the transmission of impulses that modulate the release of LH-releasing factor.

The increase in MAO activity in the frontal cortex may reflect the heightened neural activity associated with this area before ovulation (*8*).

As an alternate explanation, the rise in MAO activity in the brain areas studied may represent only the sum total of all neural activity in the brain leading to ovulation and not represent the neurophysiological events controlling gonadotropin secretion.

Table 1. Monoamine oxidase activity in various areas of rat brain during the estrous cycle. (Monoamine oxidase activity is expressed as micrograms of substrate oxidized per gram of brain tissue per hour.)

Brain area	MAO activity ($\mu g\ g^{-1}\ hr^{-1}$)
Diestrus	
Amygdala	6.38±0.48
Frontal cortex	6.87±0.70
Hypothalamus	9.30±0.82
Proestrus	
Amygdala	16.64±1.87
Frontal cortex	14.53±0.52
Hypothalamus	20.96±2.70
Estrus	
Amygdala	15.88±1.13
Frontal cortex	14.62±0.42
Hypothalamus	21.53±1.04

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References and Notes

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